Prevalence of chronic kidney disease-associated pruritus among adult dialysis patients
A meta-analysis of cross-sectional studies
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Abstract
Chronic kidney disease (CKD)-associated pruritus is a common adverse symptom in patients with end-stage renal disease treated by dialysis. Herein, a systematic review and meta-analysis of the prevalence of CKD-associated pruritus among adult dialysis patients was conducted.

An electronic search of PubMed, Web of Science, Elsevier, Wanfang, and Chinese National Knowledge Infrastructure databases was conducted from inception to November 23, 2016, and all cross-sectional studies that reported the prevalence of CKD-associated pruritus in dialysis were collected. The pooled prevalence was estimated by random-effects model. Potential publication bias was evaluated by the funnel plot as well as Begg and Egger tests.

After rigorous screening, a total of 42 studies conducted on 11,800 patients were included in this study. The overall prevalence of CKD-associated pruritus among adult dialysis patients was 55% (95% confidence interval [CI], 49–61, I² = 97.6%), the stratification of which was 55% (65% CI, 45–65, I² = 94.7%) in men and 55% (95% CI, 46–66, I² = 93.3%) in women. In hemodialysis (HD) patients, the prevalence of CKD-associated pruritus was 55% (95% CI, 49–62, I² = 97.9%), while in peritoneal dialysis (PD) patients, it was 56% (95% CI, 44–68, I² = 89.9%). The prevalence of CKD-associated pruritus for mean dialysis duration <40 months was 56% (95% CI, 48–63, I² = 75.1%), while for that for mean dialysis duration ≥40 months was 50% (95% CI, 36–64, I² = 99.1%).

The prevalence of CKD-associated pruritus is high in HD and PD. The prevalence among adult dialysis patients is comparable between China and foreign countries as well as between females and males. Studies with the similar disease definition and analysis of the effects of risk factors on CKD-associated pruritus are needed.

Abbreviations: AHRQ = Agency for Healthcare Research and Quality, CI = confidence interval, CKD = chronic kidney disease, ESRD = end-stage renal disease, HD = hemodialysis, HRQOL = health-related quality of life, PD = peritoneal dialysis, SF-36 = 36-Item Short Form Health Survey, VAS = visual analog scale.

Keywords: chronic kidney disease-associated pruritus, hemodialysis, meta-analysis, peritoneal dialysis, prevalence

1. Introduction
Chronic kidney disease (CKD) refers to a condition where the kidneys are damaged or the glomerular filtration rate has been <60 mL/min per 1.73 m² for >3 months.[1] End-stage renal disease (ESRD) is the terminal stage of various CKDs and its incidence has risen markedly in the past 30 years.[2] Jha et al reported that the highest incidence of ESRD was found in Taiwan (about 410 per million per year), while the lowest was in Paraguay (about 10 per million per year). In general, the majority of countries have a high incidence of ESRD (100–200 per million per year).[1] Over 80% of patients in developed countries received treatment for ESRD[3] and most of them chose to be treated with dialysis to increase their lifespan.

As the most common skin symptom in ESRD, pruritus is widely known as “uremic pruritus.” Because there is no true cause–effect relationship with uremia, and pruritus is usually not observed in patients with acute kidney disease, we and others have suggested that the term “CKD-associated pruritus” is more precise.[4,5] In addition, CKD-associated pruritus could be difficult to distinguish from pruritus caused by nonrenal comorbidities typically linked with CKD, for instance, thyroid disease and hematological malignancy.[6] Previous studies have reported variable prevalence rates of 18% to 70% in patients with variable severity.[7–11] Patients with peritoneal dialysis (PD) or hemodialysis (HD) suffer from different CKD-associated pruritus at different rates, which requires further study.[8–11]

As a distressing symptom in ESRD patients, CKD-associated pruritus impairs their health-related quality of life (HRQOL).[12–14] and increases the risks of death and hospitalization.[15] In addition, patients with CKD-associated pruritus have a poorer quality of sleep or more serious depression as compared to patients without CKD-associated pruritus.[16–18] Notably, there is no single study tool for the measurement of CKD-associated pruritus. Many risk factors have been linked with CKD-associated pruritus in dialysis patients with ESRD,[19–21]...
although with conflicting findings. Hence, the prevalence of CKD-associated pruritus in dialysis patients should be investigated in order to take appropriate measures for reducing the disease burden.

Till date, a limited comprehensive review of the prevalence and associations of CKD-associated pruritus in patients treated with dialysis has been performed. Therefore, a meta-analysis was needed to assess the absolute and relative prevalence, and risk factors for CKD-associated pruritus in dialysis patients.

2. Materials and methods

2.1. Data sources and search strategies

An electronic search of PubMed, Chinese National Knowledge Infrastructure, Elsevier, Web of Science, and Wanfang databases was conducted from inception to November 23, 2016. The search terms, like “dialysis,” “hemodialysis,” and “peritoneal dialysis,” were united with the terms “pruritus,” “itch,” and “prevalence” to generate the references. We examined references of all retrieved studies and contacted authors to obtain further information, if necessary. The literature search was independently conducted by 2 reviewers (XH and YS) using a study selection form.

2.2. Eligibility criteria

Eligibility criteria were cross-sectional studies reporting the prevalence of CKD-associated pruritus in adult ESRD patients with dialysis. CKD-associated pruritus examined by a trained clinician was defined as an uncomfortable sensation of the skin resulting in the desire to scratch.[22] Editorials, letters, or case reports where no data on prevalence could be evaluated were excluded. Unpublished materials were also excluded.

2.3. Data extraction

Relevant data were independently extracted by 2 reviewers (XH and YS), and a discussion was held to achieve consensus. A third reviewer (MY) was consulted, if necessary. The extracted data included: first author, year of publication, country, study populations, sample size, prevalence, study methods quality, dialysis duration, study tools, and significant correlates of pruritus.

2.4. Study quality assessment

The quality of cross-sectional studies was estimated by Agency for Healthcare Research and Quality (AHRQ) ranging from 0 to 11 scores. Hu et al.[23] also assessed the quality of cross-sectional studies using AHRQ. The instrument consisted of 11 points. If the answer was “NO” or “UNCLEAR,” the item was scored “0”; conversely, the item was scored “1.” According to the summarized scores, the quality of articles was classified into the following 3 levels: 0 to 3 was considered as low quality; 4 to 7 as moderate quality; and 8 to 11 as high quality.

2.5. Statistical analysis

All analyses were performed with STATA (version 12.0). Estimates were expressed as the prevalence and 95% confidence intervals (CIs) for each study.[24] Prevalence estimates from individual studies were pooled using a random-effects model.[25,26] subgroup analyses were also used to study populations, gender, country, study tools, sample size, and year of publication. The heterogeneity across included studies was analyzed using Cochran Q (heterogeneity χ²) and I² statistics.[27] In the χ²-based Q test, P < .10 indicated no heterogeneity, while P > .10 was deemed as vital heterogeneity. Across the study, I² was used to evaluate total variation due to heterogeneity rather than chance (<25% was considered as low heterogeneity, 25% to 50% as moderate, and >50% as major heterogeneity). The funnel plot was used to examine potential publication bias.[28] Funnel plot asymmetry was evaluated using Egger linear regression test, where P < .05 was considered as statistically significant publication bias.

2.6. Ethics approval

All analyses were based on previously published studies. Hence, ethics approval or patient consent was not required.

3. Results

3.1. Search results

Figure 1 shows the detailed study selection process. A total of 6995 articles were identified by the literature search, of which 634 were from PubMed, 789 from Web of Science, 2684 from Elsevier, 1598 from Wanfang Data, and 1290 from CNKI. A total of 2979 duplicate studies were removed using NoteExpress software. Among the remaining studies, 3682 studies were excluded after screening the titles and abstracts. Therefore, 154 studies were chosen after full-text screening, of which 112 studies were excluded due to the following reasons: 27 studies included adolescent patients; 37 studies did not have data on the prevalence; 8 studies had incomplete data; 40 studies were not cross-sectional studies. Finally, 42 studies were included in the meta-analysis.

3.2. Study characteristics and quality assessment

Table 1 provides a summary of the characteristics of the included studies and detailed quality information. Our analysis included 42 eligible articles, which were all cross-sectional studies. Of these, 11 studies were published in Chinese, and 31 studies in English. The sample size of the included studies was 29 to 1773 patients, while a total of 11,800 patients were included in the 42 studies. A total of 24 studies assessed CKD-associated pruritus with a visual analog scale (VAS), which was reported from 0 to 10 (0=no pruritus and 10=intolerable pruritus). Moreover, 22 studies assessed CKD-associated pruritus by other validated and
| Reference, year | Country | Study design | Setting | Sample size | Prevalence, % | Dialysis duration, mo | Woman, % | Study tool |
|----------------|---------|--------------|---------|-------------|---------------|----------------------|----------|-----------|
| Weiss et al, 2016 \[8\] | Germany | HD CS | 7 | 860 | 18 | 57.6±55.2 | 42.8 | A 10-cm VAS |
| Wu et al, 2016 \[8\] | Taiwan | HD CS | 7 | 296 | 38.2 | None | 44.6 | A 10-cm VAS |
| Wu et al, 2016 \[8\] | Taiwan | PD CS | 7 | 84 | 28.6 | None | 65.5 | A 10-cm VAS |
| Min et al, 2016 \[13\] | Korea | HD CS | 6 | 425 | 46.3 | None | 44.2 | A 10-cm VAS |
| Min et al, 2016 \[13\] | Korea | PD CS | 6 | 223 | 62.8 | None | 40.8 | A 10-cm VAS |
| Snit et al, 2013 \[11\] | Poland | HD CS | 6 | 143 | 41.4 | 54.6±46.44 | 44.8 | A 10-cm VAS |
| Snit et al, 2013 \[11\] | Poland | PD CS | 6 | 54 | 36.3 | 39.48±38.4 | 44.4 | A 10-cm VAS |
| Susel et al, 2014 \[14\] | Poland | HD CS | 5 | 200 | 38 | Not reported | 38 | A 10-cm VAS |
| Weiss et al, 2015 \[15\] | Germany | HD CS | 8 | 860 | 25.2 | 58±56.2 | 42.8 | A 10-cm VAS |
| Duque et al, 2006 \[18\] | USA | HD CS | 7 | 105 | 57.1 | None | 45 | A 10-cm VAS |
| Caplin et al, 2011 \[19\] | UK | HD CS | 6 | 508 | 52 | Not reported | 46.4 | A 10-cm VAS |
| Kasumaci, 2011 \[20\] | Turkey | HD CS | 4 | 130 | 85.4 | Not reported | 42.3 | A 10-cm VAS |
| Gatmiri et al, 2013 \[21\] | Iran | HD CS | 6 | 39 | 58.6 | None | 35.7 | A 10-cm VAS |
| Chiu et al, 2008 \[22\] | Taiwan | HD CS | 8 | 321 | 62.6 | Not reported | 50.5 | A 10-cm VAS |
| Chen et al, 2013 \[23\] | Taiwan | HD CS | 7 | 321 | 63.2 | None | 50.5 | A 10-cm VAS |
| Ko et al, 2014 \[24\] | Taiwan | HD CS | 5 | 178 | 34.8 | 67.2±52.8 | 47 | A 10-cm VAS |
| Narita et al, 2009 \[25\] | Japan | HD CS | 5 | 1773 | 72.9 | 123.6±90.1 | 41.1 | A 10-cm VAS |
| Malekmakan et al, 2015 \[26\] | Iran | HD CS | 4 | 241 | 40.2 | Not reported | 46.9 | A 10-cm VAS |
| Subach and Marx, 2002 \[27\] | USA | HD CS | 6 | 70 | 70 | Not reported | 58.6 | A modified detailed scoring system proposed by Du |
| Makhlongh et al, 2013 \[28\] | Iran | HD CS | 6 | 153 | 61.4 | Not reported | 47.7 | A 10-cm VAS |
| Tajaksh et al, 2013 \[29\] | Iran | HD CS | 5 | 100 | 39 | Not reported | 49 | A 10-cm VAS |
| Weisbord et al, 2005 \[30\] | USA | HD CS | 7 | 162 | 54 | Not reported | 38.3 | A 10-cm VAS |
| Peres et al, 2014 \[31\] | Brazil | HD CS | 4 | 145 | 53.8 | 43.3±42.3 | 35.9 | A 10-cm VAS |
| Zucker et al, 2003 \[32\] | USA | HD CS | 7 | 219 | 47.9 | 48±51.6 | 38 | A modified detailed scoring system proposed by Du |
| Mourad et al, 2014 \[33\] | Egypt | HD CS | 5 | 93 | 51.6 | 38.77±10.6 | 39.8 | A 10-cm VAS |
| Dyachenko et al, 2006 \[34\] | Israel | HD CS | 6 | 70 | 74.3 | 36±28.8 | 40 | A 10-cm VAS |
| Lopes et al, 2012 \[35\] | Brazil | HD CS | 6 | 980 | 43.8 | Not reported | 40.3 | A 10-cm VAS |
| Khanna et al, 2013 \[36\] | India | HD CS | 6 | 200 | 58 | 17.1±16.3 | 43.5 | A 10-cm VAS |
| Congic et al, 2012 \[37\] | Bosnia and Herzegovina | HD CS | 6 | 200 | 29 | 62.6±57 | 39 | A 10-cm VAS |
| Stahlé-Backdahl et al, 1988 \[38\] | Sweden | HD CS | 6 | 29 | 65.5 | Not reported | 51.7 | A 10-cm VAS |
| Wang et al, 2007 \[39\] | China | HD CS | 7 | 190 | 48.9 | 41±36.1 | 43.7 | A 10-cm VAS |
| Xia et al, 2009 \[40\] | China | HD CS | 6 | 238 | 55.5 | 58.3±37.3 | 49.2 | A 10-cm VAS |
| Wang et al, 2012 \[41\] | China | HD CS | 6 | 97 | 55.7 | 13.9±10.9 | 40.2 | A 10-cm VAS |
| Wang et al, 2006 \[42\] | China | HD CS | 7 | 126 | 73.8 | 56.3±37.31 | 50 | A 10-cm VAS |
| Wang et al, 2012 \[43\] | China | HD CS | 7 | 97 | 55.7 | 13.9±10.9 | 40.2 | A 10-cm VAS |
| Hao et al, 2010 \[44\] | China | HD CS | 6 | 125 | 64.8 | Not reported | 47.2 | A 10-cm VAS |
| Wang et al, 2012 \[45\] | China | HD CS | 8 | 301 | 77.7 | 75.12±68.84 | 41.2 | A 10-cm VAS |
| Zhou et al, 2012 \[46\] | China | HD CS | 6 | 280 | 73.2 | 40.27±30.24 | 42.1 | A 10-cm VAS |
| Tu et al, 2016 \[47\] | China | HD CS | 6 | 158 | 62.7 | 39.8±44.1 | 39.2 | A 10-cm VAS |
| Gao et al, 2010 \[48\] | China | HD CS | 8 | 182 | 97.8 | Not reported | 51.6 | A 10-cm VAS |
| Liu et al, 2016 \[49\] | China | HD CS | 4 | 91 | 55 | Not reported | 44 | A 10-cm VAS |
| Li et al, 2015 \[50\] | China | PD CS | 7 | 362 | 65.2 | Not reported | 46.4 | A 10-cm VAS |
| Figueiredo et al, 2012 \[51\] | UK | PD CS | 6 | 41 | 78 | Not reported | 44 | A 10-cm VAS |
| Tessari et al, 2009 \[52\] | Italy | PD CS | 5 | 139 | 51.1 | Not reported | 47.2 | A 10-cm VAS |
| Tesseriet al, 2009 \[53\] | Italy | PD CS | 5 | 30 | 56.7 | Not reported | 47.2 | A 10-cm VAS |
| Hajheydari and Makhlongh, 2008 \[54\] | Iran | HD CS | 3 | 101 | 38.6 | 36±11 | 42.6 | A 10-cm VAS |

Age and duration of dialysis listed as range or mean±standard deviation, when available. Only studies that reported at least 1 correlate or predictor were included in this table.

Study design: HD = hemodialysis; PD = peritoneal dialysis; CS = cross-sectional study; KDQOL-SF = Kidney Disease Quality of Life Short Form; VAS = visual analog score.

Quality rated out of 8: 0 to 3 = low quality; 4 to 7 = medium quality; and 8 to 11 = high quality.

None: Not reported; 1 = community; 2 = hospital; and 3 = community and hospital.
invalid study tools. Thirty-six (85%) studies (10,003 patients) only included HD patients, 2 (5%) studies (403 patients) only included PD patients, and 4 (10%) studies (1394 patients) included both HD and PD patients.

The quality scores of cross-sectional studies ranged from 3 to 8. Four studies were high quality, 37 studies were moderate quality, and 1 was low quality. Twenty articles reported the response rate and 15 articles had a sample size >200.

3.3. Prevalence of CKD-associated pruritus among dialysis patients

Among the adult dialysis patients, the prevalence of CKD-associated pruritus in each study ranged between 18% and 97.8% (Fig. 2; Table 1), and the overall prevalence of CKD-associated pruritus was 55% (95% CI, 49–61), with a high heterogeneity among studies ($I^2 = 97.6\%$) (Fig. 2).

3.4. Subgroup analysis

Table 2 shows the results of subgroup analysis, such as gender, study populations, assessment tools, dialysis duration, different countries, and sample size. A total of 15 studies reported the prevalence of CKD-associated pruritus in males and females. The pooled prevalence in males was 55% (95% CI, 45–65), and that in females was 55% (95% CI, 46–63). Forty studies with HD patients showed that the prevalence of CKD-associated pruritus was 55% (95% CI, 49–62), while that in the PD patients was 56% (95% CI, 44–68). The pooled prevalence of CKD-associated pruritus among male HD patients was 54% (95% CI, 44–65), while among females was 55% (95% CI, 44–65). The pooled prevalence of CKD-associated pruritus in dialysis patients assessed with a VAS was 51% (95% CI, 42–60). Meanwhile, the pooled prevalence of CKD-associated pruritus in dialysis patients assessed by other tools was 60% (95% CI, 52–68). The pooled prevalence of CKD-associated pruritus in China was 61% (95% CI, 52–69), whereas in foreign countries, it was 52% (95% CI, 44–60). The prevalence of CKD-associated pruritus was 58%.

![Figure 2. Forest plot of the 42 studies included meta-analysis.](image)

Table 2
The prevalence of pruritus in different subgroup of adult dialysis patients.

| Character                  | Number of studies | Sample size | Prevalence (95% CI), % | Heterogeneity |
|----------------------------|-------------------|-------------|------------------------|---------------|
| Overall                    | 42                | 11,800      | 55 (49–61)             | 1902.49 < .001 97.63 |
| Gender                     |                   |             |                        |               |
| Male                       | 15                | 1981        | 55 (45–65)             | 262.83 < .001 94.67 |
| Female                     | 15                | 1645        | 55 (46–65)             | 208.39 < .001 93.28 |
| Study populations          |                   |             |                        |               |
| Hemodialysis               | 40                | 11,326      | 55 (49–62)             | 1835.75 < .001 97.88 |
| Peritoneal dialysis        | 6                 | 474         | 56 (44–68)             | 49.46 < .001 89.89 |
| Hemodialysis               |                   |             |                        |               |
| Male                       | 14                | 1787        | 54 (44–65)             | 237.23 < .001 94.52 |
| Female                     | 14                | 1477        | 55 (44–65)             | 191.75 < .001 93.22 |
| Study tools                |                   |             |                        |               |
| Visual analog scale        | 24                | 7727        | 51 (42–60)             | 1292.55 < .001 98.22 |
| Other tools                | 22                | 4073        | 60 (52–68)             | 567.81 < .001 96.3 |
| Country                    |                   |             |                        |               |
| China                      | 17                | 3447        | 61 (52–69)             | 433.1 < .001 96.31 |
| Other countries            | 29                | 8353        | 52 (44–60)             | 1287.73 < .001 97.83 |
| Sample size                |                   |             |                        |               |
| <100                       | 13                | 905         | 58 (51–65)             | 54.97 < .001 78.17 |
| 100–199                    | 15                | 2137        | 59 (48–70)             | 380.99 < .001 96.33 |
| ≥200                       | 18                | 8758        | 51 (41–69)             | 1402.41 < .001 98.79 |
| Dialysis duration          |                   |             |                        |               |
| Mean < 40                  | 8                 | 809         | 56 (48–63)             | 28.05 < .0001 75.05 |
| Mean ≥ 40                  | 13                | 5424        | 50 (36–64)             | 1308.80 < .0001 99.08 |

CI = confidential interval.
respectively. While some previous studies[11,63,67] had shown CKD-associated pruritus in HD and PD was 55% and 56%, pruritus in the included studies. races, and sample sizes), and the de study design, selection of participants (e.g., study populations, heterogeneity in the prevalence data may be due to the different accounted for a large proportion of dialysis patients. The prevalence of CKD-associated pruritus is a common cutaneous change in adult dialysis patients in each study was between 18% and 97.8%. The pooled prevalence of 42 studies was 55% (95% CI, 49–61). Patients suffering from CKD-associated pruritus accounted for a large proportion of dialysis patients. The heterogeneity in the prevalence data may be due to the different study design, selection of participants (e.g., study populations, races, and sample sizes), and the definition of CKD-associated pruritus in the included studies.

This meta-analysis showed that the pooled prevalence of CKD-associated pruritus in HD and PD was 55% and 56%, respectively. While some previous studies[11,63,67] had shown similar results, Min et al[10] found that HD patients had a higher prevalence of CKD-associated pruritus than PD patients. Moreover, Wu et al[9] found that HD patients had a significantly higher severity of CKD-associated pruritus than PD patients, while Mistik et al[68] showed the opposite results. Younger patients, shorter duration of dialysis and greater target dose for dialysis adequacy of solute clearance lead to lower severity of CKD-associated pruritus. However, the optimal treatment for reducing CKD-associated pruritus remains unknown. Therefore, randomized controlled trials are needed.

Previous studies reported that ESRD patients had poor HRQOL as compared to the general population[69,70] Fei et al[31] evaluated the HRQOL using 36-Item Short Form Health Survey (SF-36) among HD and PD patients, and found that PD patients with HRQOL were better than HD patients, which was consistent with Huarong et al.[72] However, Xing et al[73] suggested no difference between PD and HD patients. These studies measured HRQOL using the SF-36, which is widely validated and applied to assess the QOL of patients and the general population.[74] The most optimal dialysis modality that could be widely used remains unknown.

Differences in the prevalence were observed among countries. For instance, in the United States, Duque et al[59] conducted a cross-sectional study including 105 HD participants and discovered that the prevalence of CKD-associated pruritus was 57.1%. Meanwhile, Garmiri et al[31] studied 99 HD patients in Iran and found that the prevalence was 58.6%. These studies were consistent with the findings of the present meta-analysis. Nevertheless, other studies yielded different results. Yun and Ying[59] surveyed 182 HD patients in China and found a high prevalence of 97.8%. Another cross-sectional study in Turkey also showed a high prevalence of 85.4%.[30] Other studies found a lower prevalence than our study. For example, Weiss et al[8] conducted a cross-sectional study with 860 HD patients in Germany and found that the prevalence was only 18%. These discrepancies were perhaps due to regional, racial, and economic differences worldwide.

There are many study tools for measuring pruritus, such as a 4-item Itch Questionnaire and VAS.[17] Some patients were examined by a trained dermatologist.[39,40] Because majority of the studies used a VAS for the assessment of CKD-associated pruritus, the included studies were divided into 2 groups: those using a VAS and those using other tools. Patients measured by other study tools had a higher pooled prevalence of CKD-associated pruritus than those evaluated by a VAS (60% vs. 51%). Our study also found differences in classifying the high level of pruritus by a VAS. Thus, a more standardized questionnaire is needed to characterize pruritus.

Gender was related to the prevalence of CKD-associated pruritus in some studies with a small sample size.[10,31] However, our results indicated that the total prevalence rate of CKD-associated pruritus in both males and females was 55%, which was in agreement with the findings of Yun-Feng et al[51] and Malekmakan et al[36] with large sample sizes. Age, depression, quality of sleep, parathyroid hormone (PTH), and dialysis duration were predictors of pruritus in few studies,[17,29,46,50,58,76] Further studies are needed to explore other predictors of CKD-associated pruritus.[77,78]

Dialysis duration is an important factor affecting the prevalence of CKD-associated pruritus. Our findings indicated that the dialysis duration was negatively associated with the prevalence of CKD-associated pruritus, which was different from previous reports.[11,17,35,43,45,50–54] That revealed no correlation between the 2. The following reasons could explain this phenomenon. First, most studies had a small sample size, and did not analyze whether dialysis duration was linked to the

Figure 3. Funnel plot of the 42 studies included in the meta-analysis.
prevalence of CKD-associated pruritus. Second, with the improvement of medical and health conditions, and living environment, along with patients’ self-care awareness, efficient dialysis could provide a clinical benefit in some aspects. Third, since most studies had a short dialysis duration, we divided the dialysis duration into 2 groups, which may have oversimplified the results. Moreover, the prevalence of CKD-associated pruritus was correlated with the duration of renal chronic disease. Wikström[70] and Szepietowski et al[80] reported that dialysis duration was positively correlated with the intensity of CKD-associated pruritus. Future multicenter and large sample size studies are needed to arrive at a definite conclusion.

There were limitations to several studies on CKD-associated pruritus. Most patients had ESRD, were undergoing dialysis,[81][82] and were adults. Children also had a higher prevalence of CKD-associated pruritus.[73][83] There was no unique definition of the measured time point of CKD-associated pruritus in the majority of studies. Further studies are needed on this important and large subgroup of patients with CKD.

The present study had several notable limitations. First, the heterogeneity among the studies was high both in the total population and in the subgroups. Factors, such as age, gender, and disease duration might contribute to the risks of CKD-associated pruritus among dialysis patients. Second, all included studies were published only in English and Chinese. Third, sample sizes of the included studies were small. More than half of the studies included <200 people. Therefore, multicenter studies with a large sample are required to investigate the prevalence, severity, and association of CKD-associated pruritus among adult dialysis patients.

5. Conclusion
This meta-analysis demonstrated that more than half of adult dialysis patients suffered from CKD-associated pruritus. Both HD and PD patients had a high prevalence of CKD-associated pruritus. The prevalence of CKD-associated pruritus among adult dialysis patients was higher in China than in other countries. A multidisciplinary team would be indispensable for improving CKD-associated pruritus among dialysis patients in the future.

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Conceptualization: Xinmiao Hu, Yan Sang.
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