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The impact of nurse-led care in chronic kidney disease management: a systematic review and meta-analysis

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Abstract

Background A multidisciplinary approach is widely recommended for the effective management of chronic kidney disease (CKD), with the objective of improving both clinical and psychosocial outcomes. However, resource constraints and increasing demands on healthcare systems have emphasized the necessity for alternative models of care, such as nurse-led interventions. These interventions possess the potential to address critical challenges in CKD management by providing accessible, patient-centered care across diverse healthcare settings.

Objective This systematic review and meta-analysis aims to compare the effects of nurse-led care with routine care in CKD management to determine its efficacy across diverse cultural backgrounds.

Methods Following PRISMA guidelines, a comprehensive search was conducted on PubMed, EMBASE, Scopus, and Cochrane databases, supplemented by manual searches and clinical trial registries. Inclusion criteria were randomized controlled trials (RCTs) involving nurse-led care for CKD patients aged 18 or older. Data extraction focused on study and baseline characteristics, and outcomes related to quality of life (symptoms/problems associated with kidney disease, sleep, energy/fatigue, patient satisfaction, overall health, depression, physical functioning, emotional well-being, role-physical, burden of kidney disease), depression, eGFR, and blood pressure. Statistical analysis used RevMan and STATA software, with results reported as standardized mean differences, along with their confidence intervals.

Results The analysis included 10 RCTs with a total of 964 participants. Nurse-led care significantly improved symptoms/problems associated with kidney disease, sleep quality, pain, energy/fatigue, overall health, and depression. However, no significant improvements were observed in the burden of kidney disease, physical functioning, role-physical, patient satisfaction and emotional well-being. Variability in outcomes related to depression highlights potential heterogeneity among studies. While some trials reported enhanced hospitalization rates and treatment adherence, others showed inconsistent findings, suggesting a need for more rigorous research.

Conclusion Nurse-led care provides notable benefits in managing certain aspects of CKD, including symptom control, sleep disturbances, energy levels, and overall health. However, its limited impact on kidney function and other clinical outcomes underscores the necessity for developing robust, standardized nurse-led care models and conducting long-term studies to evaluate their comprehensive efficacy.

Keywords Chronic kidney disease, Nurse-led care, Nurses, Nurses' practice patterns, Systematic review, Meta-analysis

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Background

Chronic Kidney Disease (CKD), one of the leading health issues throughout the world, affects more than 10% of the global population[1]. CKD is diagnosed when a patient's estimated glomerular filtration rate (eGFR) falls below 60 ml/min per 1.73 square meters for at least 3 months [2]. The increasing prevalence of risk factors [3], has led to a corresponding rise in CKD prevalence and morbidity, contributing to higher mortality rates globally [4]. From 1990 to 2017, the global mortality rate increased by 41.5% [5]. CKD is one of the very few non-communicable diseases leading to death, and it is expected that it will be the fifth-highest cause of mortality in the world by 2040 [6]. This growing burden highlights the urgent need for effective and accessible management strategies. Nurse-led care has emerged as a promising approach to address the clinical and psychosocial challenges faced by CKD patients, particularly in improving quality of life, symptom management, and patient outcomes.

Prompt diagnosis and effective management are critical for CKD patients. However, CKD is often diagnosed in later stages [7], leaving patients with limited treatment options. Renal Replacement Therapy (RRT) including hemodialysis (HD), peritoneal dialysis (PD), and renal transplant, becomes the primary management approach. Unfortunately, RRT is not a definitive cure and comes with somatic symptoms and complications [8]. The patient's quality of life is severely impacted, leading to depression, anxiety, stress, and cognitive issues [9].

Damage to kidneys in CKD is irreversible so the ultimate goal is to delay the progression and compensate for the loss via medication, dialysis, or transplant. As nurses work closely with patients, studies prove that they are effective in raising awareness among patients regarding their disease status and possible complications if left unmanaged [10]. Moreover, nurses can also provide individualized patient care and psychosocial support that can improve cognitive behavior and quality of life in such patients [11]. The trial led by Wong et al. [12] in 2010, demonstrated that nurse-led care shows improvement in diet and fluid restriction, patient satisfaction, symptom control, complication control, and quality of life. However, the study didn't conclusively determine its impact on health service utilization. Subsequent studies in 2014 [13] and 2015 [14] confirmed these findings but shared the limitation of being solely conducted in China, raising concerns about the generalizability of the results to more diverse populations. Additionally, Barret et al. [15] conducted a trial focusing on specific treatment goals like HbA1c control in diabetics, serum bicarbonate management in acidosis, serum LDL levels, vitamin D control, and the use of antiplatelet therapy. These findings indicated no significant differences between the nurse-led and standard care groups, with some other studies even highlighting potential risks to patient safety and cardiac health [16]. Moreover, a meta-analysis was conducted by Chen et el., 2016 [17] that included 8 studies and reported outcomes like symptoms, sleep, pain, staff encouragement, general health, energy/fatigue, and overall health. It concluded nurse-led care to be beneficial in improving certain domains of quality of life (like symptoms, sleep, staff encouragement, and energy/fatigue) but it didn't take into account the loss of follow-up and mistakenly considered sample size of [13] to be 80 instead of 69 and 66 in the intervention and control groups respectively. This inconsistency in outcomes and serious mistakes in existing literature necessitates the need for further research to establish the true efficacy of nurse-led care in CKD management.

This systematic review and meta-analysis aims to compare the effects of nurse-led care with routine care to provide a foundation for implementing nurse-led care models in the management of patients with CKD. By critically evaluating existing evidence, we seek to determine whether nurse-led care is genuinely helpful in improving CKD management or merely an unproven concept awaiting validation.

Methodology

Data sources and search strategy

This meta-analysis was conducted in concordance with the Preferred Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines [17]. An electronic search on PubMed, EMBASE, Scopus, and Cochrane was performed by two independent reviewers. Only the studies in the English language were included. Furthermore, we also searched "clinicaltrials.gov" for any relevant published or unpublished clinical trials. In addition, we manually screened the reference list of included studies, and similar review articles and meta-analyses to include potentially relevant studies. The number of studies found through each source is described in detail in the PRISMA Flow chart[18] (Fig. 1). Medical Subject Headings (MESH terms) were used to formulate the search strategy. The keywords included were "Practice Patterns, Nurses", and "kidney failure, Chronic". The PICO Table and detailed search strings are available in the supplementary file.

Protocol registration

A protocol was written for this study and was registered at PROSPERO against the registration number CRD42023472435.

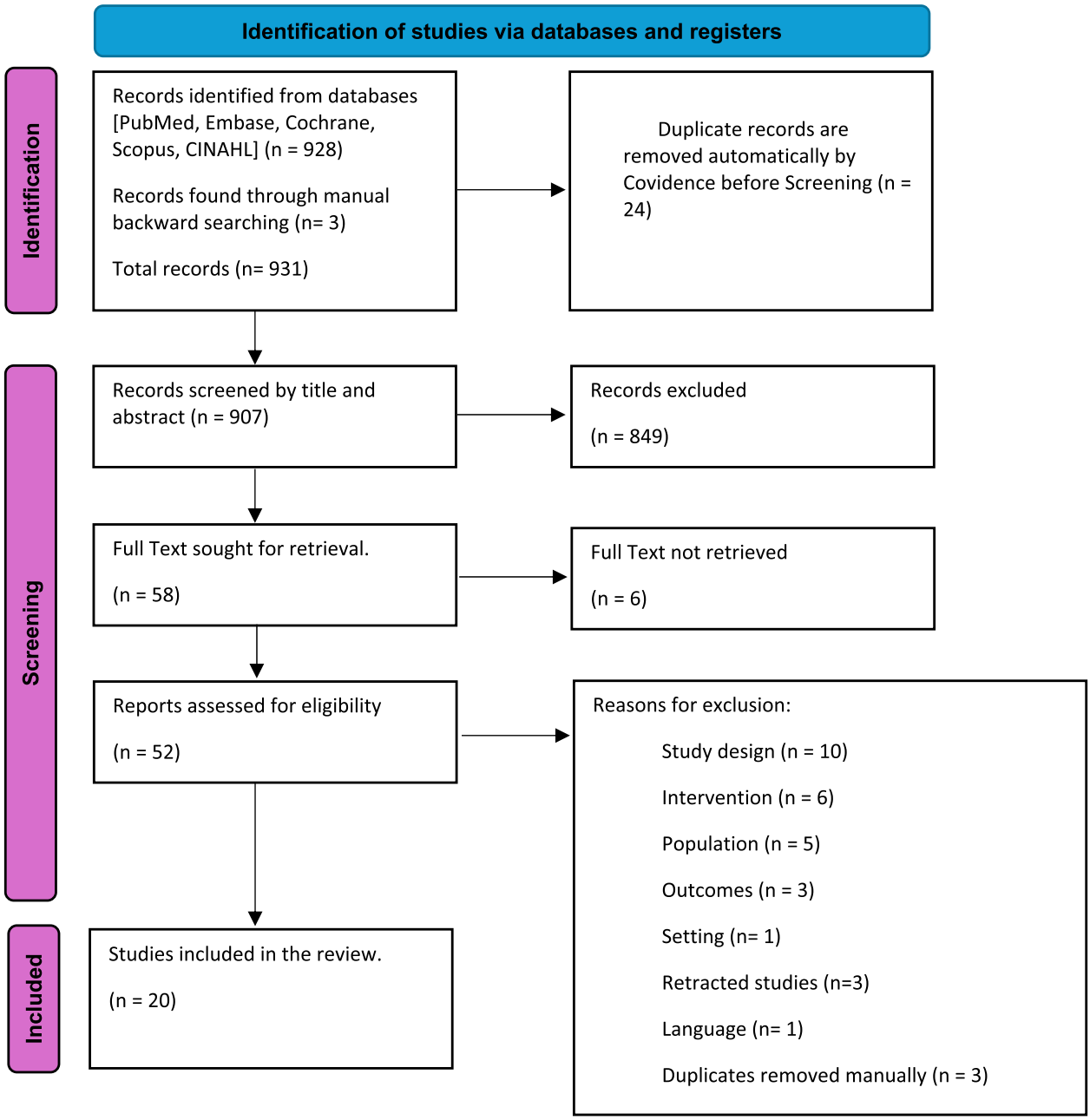

Fig. 1 PRISMA flowchart for screening of studies

Inclusion criteria

- Studies on patients with chronic kidney disease and chronic renal insufficiency with an age of 18 years or more.
- Randomized controlled trials (RCTs) conducted in any setting or country, focusing on the new healthcare models in which nurses play a leading role in the delivery of intervention.
- Only studies published in English with full-text availability.

Exclusion criteria

- Studies involving combination therapies, such as care provided jointly by nurses and physicians, nurses and pharmacists, nurses and dietitians, or nurses and

other healthcare professionals were excluded. Only studies exclusively evaluating nurse-led care were included.
- Studies with groups including mixed presentation such as a patient with concurrent chronic kidney disease and stroke or including a population diagnosed with other chronic ailments.
- Studies that did not report the effects of the intervention on chronic kidney disease outcomes.
- Studies that did not report any type of nurse-led clinic intervention, the duration of the intervention, or the frequency of the intervention.
- Studies that did not report the characteristics and baseline scores of the participants.
- Non-randomized controlled trials, crossover, pragmatic, or factorial RCTs, pilot studies, observational studies, case studies, qualitative studies, reviews, and opinion articles.
- Studies that do not mention who conducted the intervention.

Data screening

Retrieved articles were exported to Covidence where the software automatically removed duplicate studies from the list. All articles were first shortlisted based on title and abstract. The remaining articles were then thoroughly assessed by the two independent reviewers and only those articles meeting the aforementioned eligibility criteria were included. In case of a contrast of opinions, other reviewers were consulted to resolve any disparity in the result by voting. However, any unresolved conflicts were ultimately addressed through consensus, ensuring that all decisions were mutually agreed upon by the research team. Secondary screening was performed by reading the full text of the articles thoroughly. Furthermore, back screening was done by checking the references for the potential articles. Finally, 20 RCTs were included in systematic review, but only 10 RCTs were included in the meta-analysis. The detailed PRISMA flow chart is available in Fig. 1.

Data extraction

From the retrieved RCTs, data was extracted for the study characteristics, baseline characteristics, and outcomes on an online Google sheet. Baseline characteristics included mean age, gender, marital status, education level, employment status, comorbidities, and the average time on dialysis. The study characteristics included: the title of the study, authors, year of publication, journal in which the study was published, country of first author, city, and country where the research took place, sample size, inclusion criteria, exclusion criteria, intervention details, comparison/control group details and outcomes assessed by each study. The following outcomes were included in this meta-analysis: quality of life (physical and mental well-being including quality of social interactions, cognitive function, symptoms/problems, burden of kidney disease, sexual satisfaction, social support), sleep, patient satisfaction, physical functioning, mental wellbeing, energy/fatigue, overall health, depression, estimated glomerular filtration rate (eGFR) and blood pressure (BP).

Risk of bias in included studies

The two independent reviewers used the revised Cochrane risk-of-bias tool for randomized trials (RoB 2) to assess the quality of the included trials. It evaluated five key domains: randomization process, deviations from intended interventions, missing outcome data, measurement of outcomes, and selection of reported results. Figure 2 shows the risk of bias in the 20 randomized controlled trials included in this systematic review and meta-analysis. Most studies exhibited a low risk of bias in the randomization process (D1), though a few, such as Peeters 2014 and Haan 2013, showed high risk. Deviations from intended interventions (D2) were generally low risk, with minor concerns in studies like Jadhav 2018 and O'Halloran 2020. Missing outcome data (D3) posed a high risk in studies like Arad 2021 and Fishbane 2017, while the measurement of outcomes (D4) showed a balanced mix of low and high risk, with potential biases in Barrett 2011 and Wong 2010. A significant concern was selective reporting (D5), with high risk observed in studies such as Jahromi 2016 and Yue Xian Shi 2013. Overall, while the majority of studies presented low or moderate risks of bias, there were notable concerns regarding incomplete outcome data and selective reporting, which could impact the reliability of the findings in some studies. Different studies reported different outcomes, so forest plots were created for outcomes reported by 3 or more studies. Out of the 20 studies included in the systematic review, 9 were assessed to have a high risk of bias. For the meta-analysis, 10 studies were included, of which 5 had a high risk of bias, 1 had some concerns, and 4 were deemed to have a low risk of bias. Sensitivity analysis has now been conducted by excluding studies with high risk of bias.

Statistical analysis

RevMan (Version 5.4. Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration, 2014) and STATA software (version 16.0; STATA Corporation, College Station) were used for the statistical analysis. Forest plots were computed for the visual display of results. Results were reported as standardized mean difference (SMD)

Fig. 2 Risk of bias of included studies

with a 95% confidence interval, using the random effects model. Heterogeneity among studies was calculated by Higgin I^2.

Results

The characteristics of the included studies are available in Table 1, and the baseline characteristics of the individuals included in these studies are available in Table 2. The following outcomes were analyzed.

Quality of life

Quality of life is influenced by several parameters, including the following:

Symptoms and problems associated with kidney diseases

The pooled results demonstrated a statistically significant positive effect of nurse-led care as shown in Fig. 3. At discharge, the SMD was 0.23 (95% CI: 0.04 to 0.41), with no heterogeneity ($I^2=0\%$), indicating consistent outcomes across studies. Data from six weeks after discharge showed a slightly lower SMD of 0.21 (95% CI: 0.02 to 0.40), again with no heterogeneity ($I^2=0\%$). However, in data collected at twelve weeks after discharge, the effect size increased to 0.34 (95% CI: 0.15 to 0.52), with no heterogeneity ($I^2=0\%$), suggesting no variability among the studies. The forest plot is available in Fig. 3. One of the included studies [31] had a high risk of bias so a sensitivity analysis was conducted after excluding it, the results of which are available in Fig. 4. The results, even after sensitivity analysis, were statistically significant and favored nurse-led care in improvising symptoms and problems associated with chronic kidney disease. The SMD was even increased to 0.36 (95% CI: 0.17, 0.55) at 12 weeks after discharge.

Burden of kidney diseases

This outcome was reported across five studies, but no statistically significant association was present. The forest plot is available in Fig. 5. Overall, the subgroup analysis by time points consistently demonstrated no statistically significant impact of nurse-led care on reducing the burden of kidney diseases, with highly consistent results across all studies at each time point ($I^2=0\%$). One of the included studies [31] had a high risk of bias so a sensitivity analysis was conducted after excluding it, the results of which are available in Fig. 6. The results, even after sensitivity analysis, remained statistically non-significant.

Sleep

The forest plot is shown in Fig. 7. The pooled effects at the time of discharge show no significant difference between nurse-led care and standard care (SMD: −0.07 [95% CI: −0.45, 0.31]; $p=0.73$) with high heterogeneity ($I^2=70\%$). However, nurse-led care demonstrates a significant improvement in sleep outcomes compared to standard care (SMD: 0.35 [95% CI: 0.06, 0.64]; $p=0.02$) with moderate heterogeneity ($I^2=49\%$) at six weeks after discharge. Moreover, an even higher significant improvement is observed at twelve weeks after discharge (SMD:0.49 [95% CI: 0.23, 0.74]; $p=0.0002$) with very little heterogeneity ($I^2=23\%$). The overall effect indicates a continuous statistically significant improvement in the sleeping quality of CKD patients in the intervention group with time.

Table 1 Treatment received by each arm of the study (Nurse-Led Care vs. Usual Care, with Evolving Protocols)

S. No	Author/Year/ Country	Country of recruited nurses + patients	Sample Size recruited (intervention/control)	Intervention/control	Outcomes Assessed
1	Juan Li/2014/China [13]	China	160 (80/80)	Comprehensive discharge planning protocol before discharge and a standardized 6-week post-discharge nurse-led telephone support intervention/ Routine discharge care	· Quality of life · Blood Chemistry · Complication Control · Healthcare utilization
2	Barrett/2011/Canada [15]	Canada	474 (238/236)	Usual care followed by nurse-coordinated focused care on risk factors modification. Nurse-led care focused on achieving target outcomes via pharmacological or non-pharmacological measures/ Usual care	· BP < 130/80 mm Hg, LDL < 2.5 mmol/l · HbA1C < 7% · serum bicarbonate > 22 mmol/l · serum phosphate < 1.8 mmol/l, Hb > 10.5 g/l · Fe saturation > 0.2 · RAAS blockers · Anti-platelet therapy in ischemic or diabetic patients · minimization of proteinuria · Kidney function tracked by serum creatinine every 4 months
3	Kauric-Klein/2012/Michigan [19]	Michigan (Wayne)	130	The intervention consisted of two BP education sessions; 12-week monitoring, goal setting, and reinforcement; and a 30-day postintervention follow-up period/ Normal hemodialysis treatment	· Depression · BP Knowledge · BP self-efficacy · Average Fluid gain · Average sodium intake · Medication adherence · Hemodialysis adherence
4	Arad/2021/Iran [20]	Iran	66 (33/33)	A patient education program on diet, medication use, and fluid restrictions using a patient education booklet was provided at the start. Short Message Service (SMS) based telenursing patient education program lasted for 3 months/ Routine care	· Treatment adherence · Medication adherence · Fluid restrictions · Diet recommendation · Total treatment adherence
5	Weisbord /2013/America [21]	Pennsylvania, USA	220 (100/120)	Trained nurses formulated treatment recommendations based on symptoms. Nurses reviewed patients' monthly symptom questionnaires, examined patients, formulated pharmacologic and/ or nonpharmacologic treatment recommendations based on the same treatment algorithms and their clinical judgment, and discussed these recommendations with the patient/ Control group received letters detailing symptoms and treatment algorithms, with decisions left to renal providers	· Treatment recommendations and treatments implemented during the intervention phase · Improvement in symptoms after intervention

Table 1 (continued)

S. No	Author/Year/ Country	Country of recruited nurses + patients	Sample Size recruited (intervention/control)	Intervention/control	Outcomes Assessed
6	Tsai/2015/Taiwan [22]	Taiwan	64 (32/32)	An individual coaching session taught by a nurse, prerecorded instructions on breathing technique, and practice of the breathing exercise/ The participants assigned to the control group were told that they were on a waiting list for the intervention and that placements would be made as space became available	· Self-reported depressive symptoms · Self-reported sleep quality · Health-related quality of life
7	Major/2019/United Kingdom [23]	United Kingdom	23,357 (11,651/ 11,706)	The research team downloaded an IMPAKT CKD file onto the practice network. A CKD clinical lead, with the support of an experienced CKD nurse practitioner interpreted the IMPAKT CKD data file and then, implemented patient-level CKD management interventions based on the data supported by local secondary care nephrologists where necessary. The intervention included any or all of correct clinical coding of patients with CKD, exploring ways of integrating better CKD care into day to day practice, assistance in implementing CKD guidelines, patient recall for testing, assistance in implementing BP and other CV risk factor management guidance, helping with medicines management, delivering dedicated primary care CKD clinics, and targeted management of those patients with CKD with highest number of risk factors. CKD nurse practitioners made phone contact with their allocated practices at least once weekly and visited at least twice monthly in person/ In control practices, they provided no further input into the interpretation of the file data or the management of any patients with CKD identified by IMPAKT	· Change of mean eGFR · No of the patients coded for CKD · Mean BP · Number of patients achieving NICE BP targets

Table 1 (continued)

S. No	Author/Year/ Country	Country of recruited nurses + patients	Sample Size recruited (intervention/control)	Intervention/control	Outcomes Assessed
8	Shi/2013/China [24]	China	80 (40/40)	Individual education sessions during hemodialysis treatment, 2–3 times a week for six months. These sessions covered knowledge of phosphate and phosphate binders. / Control subjects received usual medical and social care without educational materials	· Serum Calcium, phosphate, calcium-phosphorus product, albumin, and parathyroid hormone · Knowledge of biochemistry among patients
9	Jahromi/2016/Iran [25]	Jahrom, Iran	60 (30/30)	The participants allocated to the intervention group received telephone follow-up 30 days after the dialysis shift in addition to conventional treatment. / Control group received only routine care	· Depression · Anxiety · Stress
10	Peeters/2014/Netherlands [26]	Netherlands	788 (395/393)	In the intervention group, a nurse practitioner, supervised by a qualified nephrologist, actively pursued lifestyle intervention, the use of specified mandatory medication, and the implementation of current guidelines. Motivational interviewing and coaching to improve self-management by the patient were key elements in the role of nurse practitioners. /No extra measures were taken to ensure adherence to CKD guidelines in the control group	· Systolic and diastolic BP · Proteinuria · LDL cholesterol · Use of medicines (Aspirin, statins, active vitamin D, ACEIs/ARBs) · Decline in kidney function (eGFR) · Improved renal outcomes (serum creatinine)
11	Nguyen/2019/Australia [27]	Hanoi, Vietnam	135 (68/67)	Received usual CKD care along with a 12-week self-management intervention delivered by an experienced nurse teacher. The intervention involved a CKD booklet and a handout, one face-to-face session, and two brief follow-up sessions. /Received usual care consisting of brief verbal information. There was no structured program or the provision of written material to patients	· CKD self-management · Kidney Disease Knowledge · Self-efficacy for managing chronic disease · Blood Pressure · Health-related quality of life

Table 1 (continued)

S. No	Author/Year/ Country	Country of recruited nurses + patients	Sample Size recruited (intervention/control)	Intervention/control	Outcomes Assessed
12	Jadhav/2018/India [28]	India	111 (60/55)	The intervention consisted of a pre-HD preparatory program. The program consisted of three sessions, namely "CKD and its conservative management," "Understanding HD as a treatment option," and "coping with disease and HD treatment." A trained nurse with postgraduate qualifications delivered the pre-HD preparatory program in the local language (Kannada). PowerPoint presentation with simple pictures and illustrations was used as a teaching aid. An information booklet was also provided to the patients at the end of the program. / Routine care which includes instruction on medication and basic health advice	· Adaptive coping strategies among patients receiving pre-HD preparatory program
13	Chow/2010/Hong Kong [29]	Hong Kong	100 (50/50)	Patients in the study group received a comprehensive discharge planning protocol and a standardized 6-week nurse-initiated telephone follow-up regimen. / Patients in the control group received routine discharge care	· Quality of life
14	Fishbane/2017/United States of America [30]	United States of America	130 (65/65)	The Healthy initial intervention consisted of a nurse visit to the patient's house to provide health-literate patient-centered knowledge on CKD, self-management support, and various treatment options. Motivational interviews provided meaningful communication exchanges. Renal replacement therapy (RRT) modality discussions were also provided to all appropriate patients. Other essential elements of home visits were to focus on dietary education, medication reconciliation, and home-safety assessment. Following the home visit, the nurse care manager and nephrologist worked to develop a plan of care that was goal-specific and patient-centered. Patients were provided weight machines with automated recording services. Telephone follow-ups were also done by nurses. / Received usual care from their nephrologist without any of the Healthy Transitions care management program interventions	· Rate of hospitalization %age of hemodialysis therapy starts · For HD, the type of vascular access on day 1 of treatment · Preemptive kidney transplantation rates

Table 1 (continued)

S. No	Author/Year/ Country	Country of recruited nurses + patients	Sample Size recruited (intervention/control)	Intervention/control	Outcomes Assessed
15	Zuilen/2012/Netherlands [16]	Netherlands	788 (395/393)	In the intervention group, a nurse practitioner, supervised by a qualified nephrologist, actively pursued lifestyle interventions, the use of specified mandatory medication, and the implementation of CKD guidelines. / Control group received only nephrologist care	· Effect on targeting risk factors (BP, LDL, Hb, anemia, vitamin D, proteinuria, use of medications like aspirin, statins, antihypertensives, ACE inhibitors) · Number of visits to outpatient clinic department · Quality of life
16	Wong/2010/China [12]	Hong Kong, China	120 (60/60)	Received both routine care and disease management program which included the 4 Cs model consisting of comprehensiveness, collaboration, coordination, and continuity. The nurses would make phone calls to the patient every week for 6 weeks. / Received routine care which includes instruction on medication and basic health advice	· Non-adherence to diet, fluid, dialysis, and medication · Quality of life · Patient satisfaction · Symptom and complication control · Health service utilization
17	Tao/2015/China [14]	China	113 (57/56)	The intervention consisted of two components: brief incenter group exercise training and nurse case management of home exercise. / The control group received group exercise only	Gait speed · 10- repetition sit-to-stand performance · Quality of life
18	O'Halloran/2020/United Kingdom [31]	United Kingdom	36 (17/19)	Participants were provided to complete a plan by an advanced care Planning (ACP) nurse, who discussed the process with them using the booklet, "Your Life and Your Choices: Plan Ahead".'Record of my wishes' form was also added in the booklet, to help patients organize their thoughts.1–2 weeks later, the patient had to complete an ACP document with the help of an ACP nurse or a trained patient. The patient's surrogate was invited to take part in the discussion if the patient wished. ACP is meant to help patients decide what would they like/dislike to happen in the future, including any advanced decision to refuse treatment (ADRT) or do not resuscitate (DNR) decision, and what place would they like to receive future treatments. / Participants in the deferred entry group were offered the intervention 12 weeks after baseline data collection, following the collection of their 12-week outcome data	· Quality of life · Anxiety · Depression · Degree of cognitive impairment · The degree to which patients felt they had a role in shared decision-making

Table 1 (continued)

S. No	Author/Year/ Country	Country of recruited nurses + patients	Sample Size recruited (intervention/control)	Intervention/control	Outcomes Assessed
19	Haan/ 2013/ Netherlands [32]	Netherlands	54,231 (30,898/23333)	The multifaceted intervention consisted of the training of professionals, structured care by nurse practitioners, and the opportunity to ask for advice from a nephrology team. This study developed a shared care model for patients with CKD in primary care. In this model, the nurse practitioner played a central role and a nephrologist and a nephrology the nurse could be consulted. / Routine care by nephrologists	· Lowering of blood pressure · Number of patients meeting blood pressure targets · Kidney disease measures · Number of patients that reached treatment goals · Functional status of the patient
20	Lii YC/2007/Taiwan [33]	Taiwan	60 (30/30)	This psychosocial intervention used cognitive behavioral therapy and self-efficacy theory to empower patients with chronic diseases. Group sessions, led by experienced nurses, focused on stress management, coping strategies, and self-care skills. Patients learned to identify and challenge negative thoughts and develop relaxation and self-monitoring techniques. / Advice and consultation by nephrologists as per routine care	· Self-efficacy · Depression · Quality of life

The usual care protocol evolved throughout the time period in line with updates in clinical practice guidelines. Each study followed the relevant guidelines applicable during the specific time period of the study. The abbreviations used in Table 1 are as follows

ACEi Angiotensin-converting enzyme inhibitors, *ACP* Advance care planning, *ADRT* Advanced decision to refuse treatment, *ARBs* Angiotensin receptor blockers, *BP* Blood pressure, *CKD* Chronic kidney disease, *CV* Cardiovascular, *DNR* Do not resuscitate, *eGFR* Estimated glomerular filtration rate, *Fe* Iron, *Hb* Hemoglobin, *HbA1c* Glycated hemoglobin, *HD* Hemodialysis, *IMPAKT* Improving Patient Care and Awareness of Kidney Disease Progression Together (www.impakt.org.uk), *LDL* Low-density lipoproteins, *NICE* National Institute for Health and Care Excellence, *RAAS* Renin–angiotensin–aldosterone system, *RRT* Renal replacement therapy, *SMS* Short message services

Table 2 Baseline demographic and clinical characteristics of participants in the intervention and control groups

S. No	Study, Year	Sample Size	Age in years Mean (SD)		Event (male) n/N		Diabetes n/N		CVS diseases n/N	
		Nurse-led care/ Standard Care	Nurse-led care	Standard Care	Nurse-led care	Standard Care	Nurse-led care	Standard Care	Nurse-led care	Standard Care
1	Juan Li 2014 [13]	135 (69/66)	57.4 (12.8)	55.2 (11.9)	42(69)	37(66)	33(69)	27(66)	N/A	N/A
2	[19] [19]	118 (59/59)	63.4 (16.4)	56 (14.8)	28(59)	32(59)	30(59)	30(59)	N/A	N/A
3	Arad 2021 [20]	66 (33/33)	27 (11.5)	30 (9.50)	18(33)	19(33)	7(33)	6(33)	N/A	N/A
4	Tsai 2015 [22]	57 (32/25)	N/A	NA	N/A	N/A	N/A	N/A	N/A	N/A
5	Major 2019 [23]	23,357 (11,651/11706)	75.1 (11.4)	75.4 (11.3)	4417 (11,651)	4421 (11,706)	1936 (11,651)	2284 (11,706)	4750 (11,651)	4786 (11,706)
6	Weisbord 2013 [21]	220 (100/120)	62.6 (14.3)	63.9 (12)	56(100)	65(120)	51(100)	61(120)	11(100)	16(120)
7	Shi 2013 [24]	80 (40/40)	54.75 (11.86)	51.85 (13.51)	21(40)	23(40)	3 (40)	5 (40)	N/A	N/A
8	Peeters 2014 [26]	788 (395/393)	58.9 (13.1)	59.3 (12.8)	265 (395)	267 (393)	99 (395)	90 (393)	130 (395)	98 (393)
9	Nguyen 2019 [27]	135 (68/67)	48.8 (13.7)	48.9 (13.9)	29(68)	39(67)	N/A	N/A	N/A	N/A
10	Chow 2010 [29]	85 (43/42)	59.4 (13.97)	54.5 (12.8)	28(43)	24(42)	19(43)	16(42)	16(43)	12(42)
11	Fishbane 2017 [30]	126 (61/65)	66.2 (15.8)	64.5 (15.5)	37(61)	40(65)	39(61)	38(65)	N/A	N/A
12	Zuilen 2012 [16]	788 (395/393)	58.9 (13.1)	59.3 (12.8)	265 (395)	267 (393)	99 (395)	90 (393)	130 (395)	98 (393)
13	Jadhav 2018 [28]	100 (50/50)	50.08 (NA)	45.26 (N/A)	34 (50)	35 (50)	17 (50)	18 (50)	N/A	N/A
14	Wong 2010 [12]	98 (49/49)	62.4 (N/A)	62.4 (N/A)	26(49)	26 (49)	17(49)	17(49)	8(49)	8(49)
15	Tao 2015 [14]	113 (57/56)	53.02 (11.62)	56.68 (9.67)	29(57)	30(56)	5(57)	3(56)	15(57)	11(56)
16	O'Halloran 2020 [31]	36 (17/19)	75.6 (6.81)	73.2 (5.01)	14(17)	16(19)	7(17)	5(19)	N/A	N/A
17	Haan 2013 [32]	164 (90/74)	73.9 (8)	72.4 (8.2)	34(90)	39(74)	34(90)	26(74)	N/A	N/A
18	Lii YC 2007 [33]	48 (20/28)	NA	NA	10(20)	13(28)	N/A	N/A	N/A	N/A
19	Jahromi 2016 [25]	54 (27/27)	69.13 (11.82)	69.13 (11.82)	12 (27)	16 (27)	N/A	N/A	N/A	N/A
20	Barrett 2011 [15]	474 (238/236)	67 (Range: 62–72)	67 (Range: 61–72)	107 (238)	104 (236)	73 (238)	76 (236)	N/A	N/A

The following abbreviations are used in Table 2: *n* number of participants included in this category, *N* total number of people in the study, *SD* standard deviation

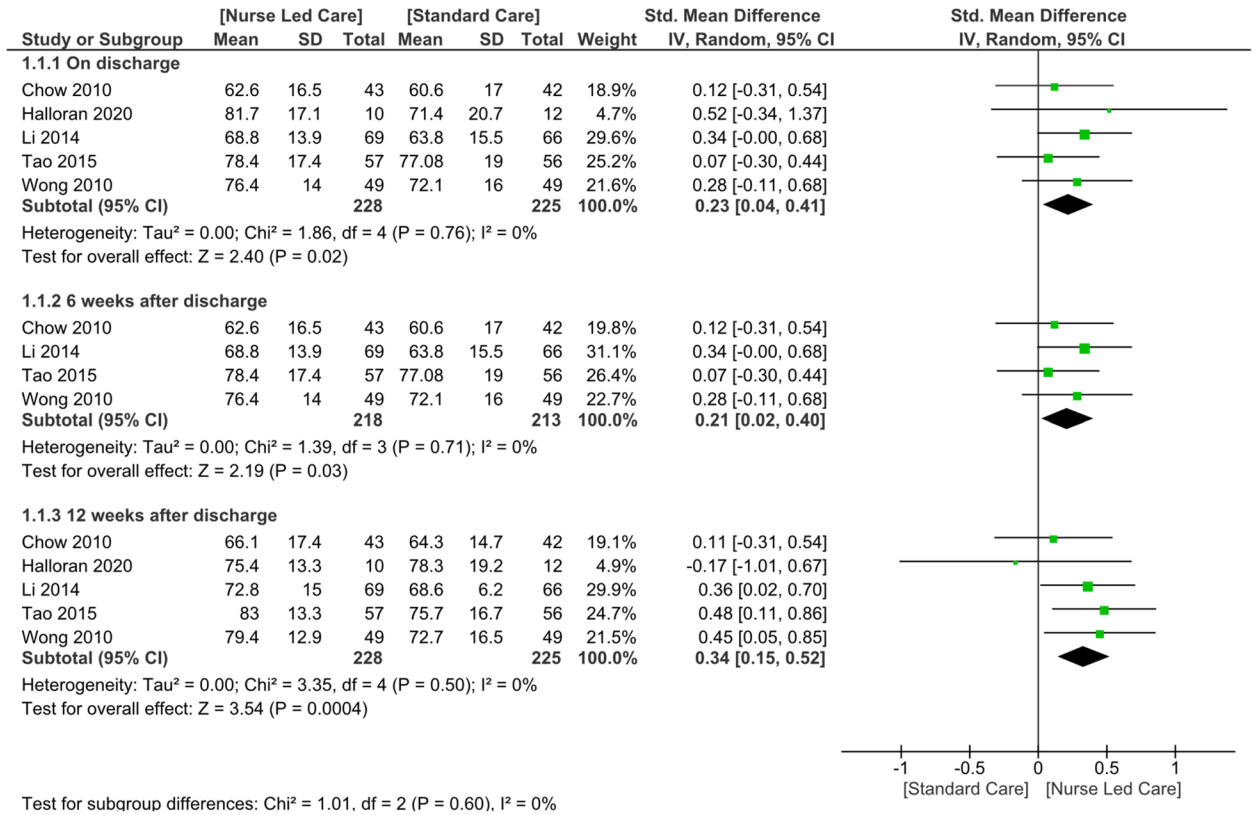

Fig. 3 Forest plot comparing symptoms and problems associated with kidney diseases

Physical functioning

Four studies investigated the impact of nurse-led care versus standard care on physical functioning across three-time points. The overall analysis, combining all time points, shows that nurse-led care does not have a significant effect on physical functioning compared to standard care with no heterogeneity ($I^2 = 0\%$), and hence strong consistency across studies. The forest plot is presented in Fig. 8.

Role-physical

Four studies investigated the effect of nurse-led care versus standard care on physical role functioning across all three different time points. At all instances, results continuously concluded that there's no statistically significant difference, that too with a high internal consistency at all instances ($I^2 = 0\%$). The forest plot is shown in Fig. 9.

Emotional well-being

Three studies [12, 13, 29] assessed the impact of nurse-led care on emotional well-being. The forest plot is available in Fig. 10. The results suggest a non-significant trend towards improved emotional well-being in the nurse-led care group compared to the standard care group at both 6 weeks as well as 12 weeks after discharge [(SMD = 0.13; 95% CI: −0.09,0.35; $p = 0.24$) and (SMD = 0.10; 95%CI: −0.12,0.32; $p = 0.35$) respectively]. The low heterogeneity ($I^2 = 0\%$) across the studies indicates consistent findings. While the data indicate a potential benefit of nurse-led care, the effect was not statistically significant.

Energy/ fatigue

Four studies [12, 13, 22, 29] analyzed, as shown in Fig. 11, to assess the impact of nurse-led care on energy/fatigue. The results demonstrate a statistically significant improvement in energy/fatigue in the nurse-led care group compared to the standard care group (SMD = 0.29; 95% CI:0.09, 0.50; $p = 0.005$) at 6 weeks after discharge. However, at 12 weeks after discharge, the results are still statistically significant but with a slightly lower SMD (SMD = 0.22; 95% CI: −0.00,0.44; p = 0.05). Hence, the low heterogeneity ($I^2 = 0\%$) across the studies indicates consistent findings, supporting the robustness of the conclusion that nurse-led care significantly enhances KDQoL-energy levels and reduces fatigue, improving quality of life in CKD patients.

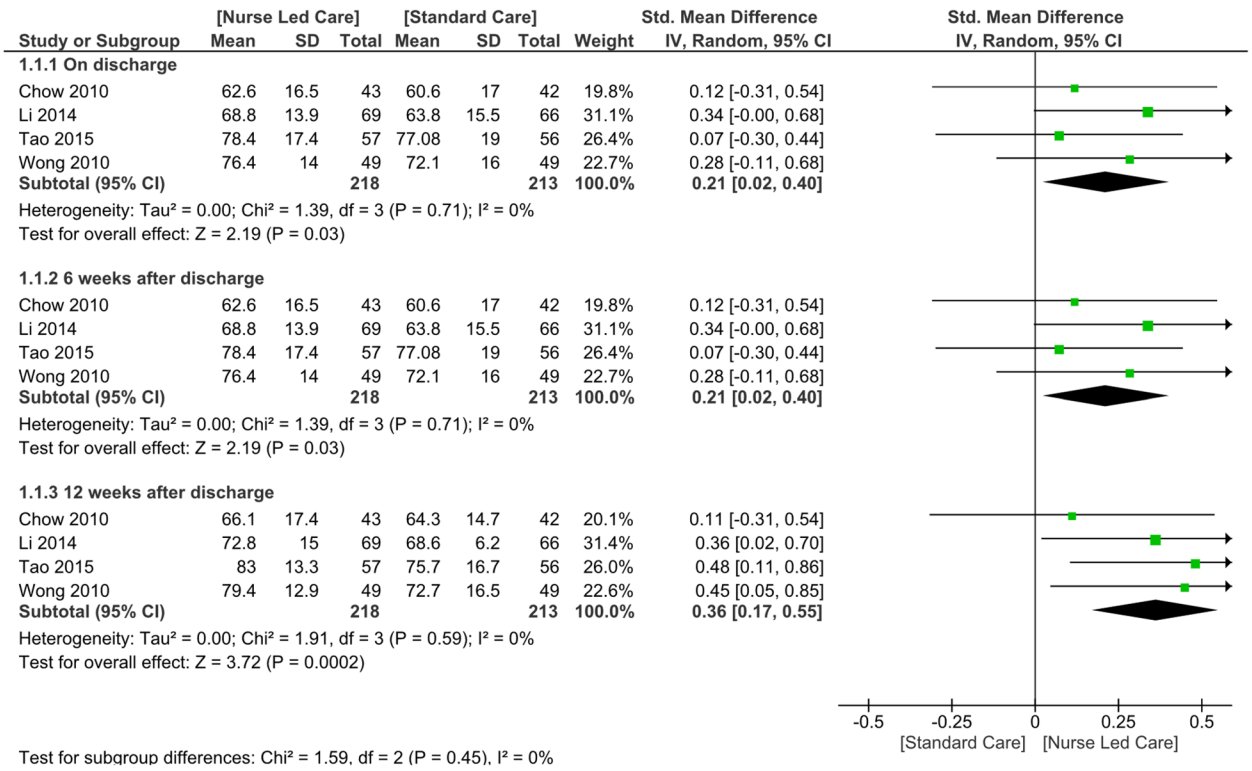

Fig. 4 Forest plot comparing symptoms and problems associated with kidney diseases (Excluding High-Risk Study)

Patient satisfaction

Three studies [12, 13, 29] were included in the meta-analysis as shown in Fig. 12. Across all three time points (on discharge, 6 weeks, and 12 weeks post-discharge), there was no statistically significant difference in patient satisfaction between nurse-led care and standard care. While there was a slight trend favoring nurse-led care at 12 weeks post-discharge, the effect was not statistically significant (SMD = 0.23; 95%CI:−0.23,0.70; p = 0.33). Additionally, there was low to moderate heterogeneity (I^2 = 0% and 12% at discharge and 6 weeks post-discharge) in most comparisons, except for the 12-week post-discharge results(I^2 = 77%) which exhibited considerable variability.

Over-all health

Four studies [12, 13, 22, 29] were included in the meta-analysis (Fig. 13). The meta-analysis shows a significant improvement in overall health with nurse-led care at 6 weeks post-discharge (SMD 0.28, 95% CI: 0.07, 0.48, p = 0.007). A smaller, borderline effect is observed on discharge (SMD 0.18, p = 0.08), while no significant difference exists at 12 weeks (p = 0.19). The findings suggest that nurse-led care may offer short-term benefits in patient health outcomes, but these effects diminish over time.

Pain

Four studies [12, 13, 22, 29] were analyzed, as shown in Fig. 14, to evaluate the impact of nurse-led care on pain management. The results indicate a statistically significant improvement in pain levels within the nurse-led care group compared to the standard care group at six weeks post-discharge (SMD = 7.56; 95% CI: 2.78–12.35; p = 0.002). However, this improvement was not sustained at 12 weeks post-discharge, with a lower and non-significant SMD (SMD = 3.96; 95% CI: −1.17–9.08; p = 0.13). Notably, the low heterogeneity across the studies (I^2 = 0%) supports the reliability of these findings. Overall, the evidence suggests that nurse-led care may provide short-term benefits for patient health outcomes, although these effects tend to diminish over time.

Depression

Given the variation in depression measurement scales across studies, a subgroup analysis was conducted to group studies that utilized the same measurement scale within each comparison. Before and after intervention results (mean and standard deviation) were taken to calculate the change in mean and standard deviation using meta-calculator. Standardized mean differences were then used to ensure that the pooled results were more consistent and directly comparable, thereby

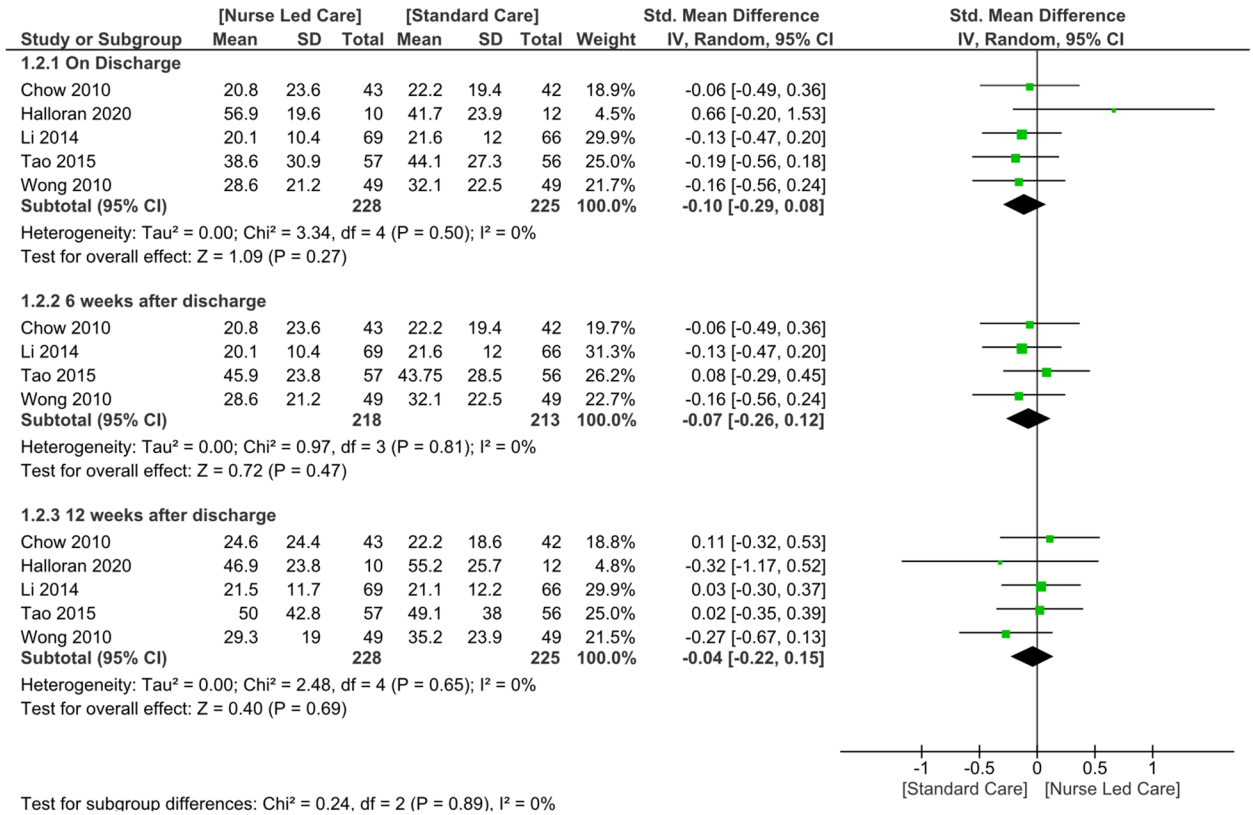

Fig. 5 Forest plot comparing burden of kidney diseases

improving the reliability of the findings within each subgroup. Four subgroups were made to assess the effect of nurse-led interventions on depression:

1. Comparison 1 included two studies [19, 21] that used PHQ-9 to assess the depression scores, with a total of 159 participants in the nurse-led care group and 179 in the standard care group. This comparison did not show a statistically significant effect, with an SMD of 0.04 (95% CI: −0.35, 0.44; $p=0.08$), and there was moderate heterogeneity ($I^2=68\%$, $p=0.83$).
2. Comparison 2 included two studies [22, 33] that used two versions of Beck's Depression Inventory scale, with a total of 52 participants in the nurse-led care group and 53 in the standard care group. The results indicated a statistically non-significant effect favoring standard care, with a standardized mean difference (SMD) of −0.53 (95% CI: −1.14, 0.08; $p=0.13$). There was a moderate level of heterogeneity between these studies ($I^2=57\%$, $p=0.09$).
3. Comparison 3 and 4 included Halloran et al., 2020 [31] and Jahromi et al., 2016 [25]. The SMD were 0.47 (95% CI: −0.19, 1.14; $p=0.16$) and −3.58 (95%CI: −4.46, −2.7; $p<0.00001$) respectively. The effect of Jahromi et al., 2016 [25] was statistically significant.

This forest plot is available in Fig. 15. The total effect size across all studies (SMD = −0.61, 95% CI: −1.35 to 0.13) is not statistically significant, and heterogeneity is high ($I^2=93\%$). Significant subgroup differences were found between the BDI-I/II and PHQ-9 measures (p = 0.005). Hence, nurse-led care shows moderate improvement in DASS-21 depression scores but no significant effect on PHQ-9, BDI, and CORE-34 outcomes compared to standard care. Moreover, 5 out of 6 included studies had a high risk of bias which makes the findings doubtful. A sensitivity analysis seems to be an appropriate approach but excluding high-risk studies leaves us with only one study [22] which is insufficient to generate a meaningful forest plot or draw any reliable conclusions.

Although data was extracted for eGFR and BP from the included studies, the results were not directly comparable due to differences in the timing of reporting.

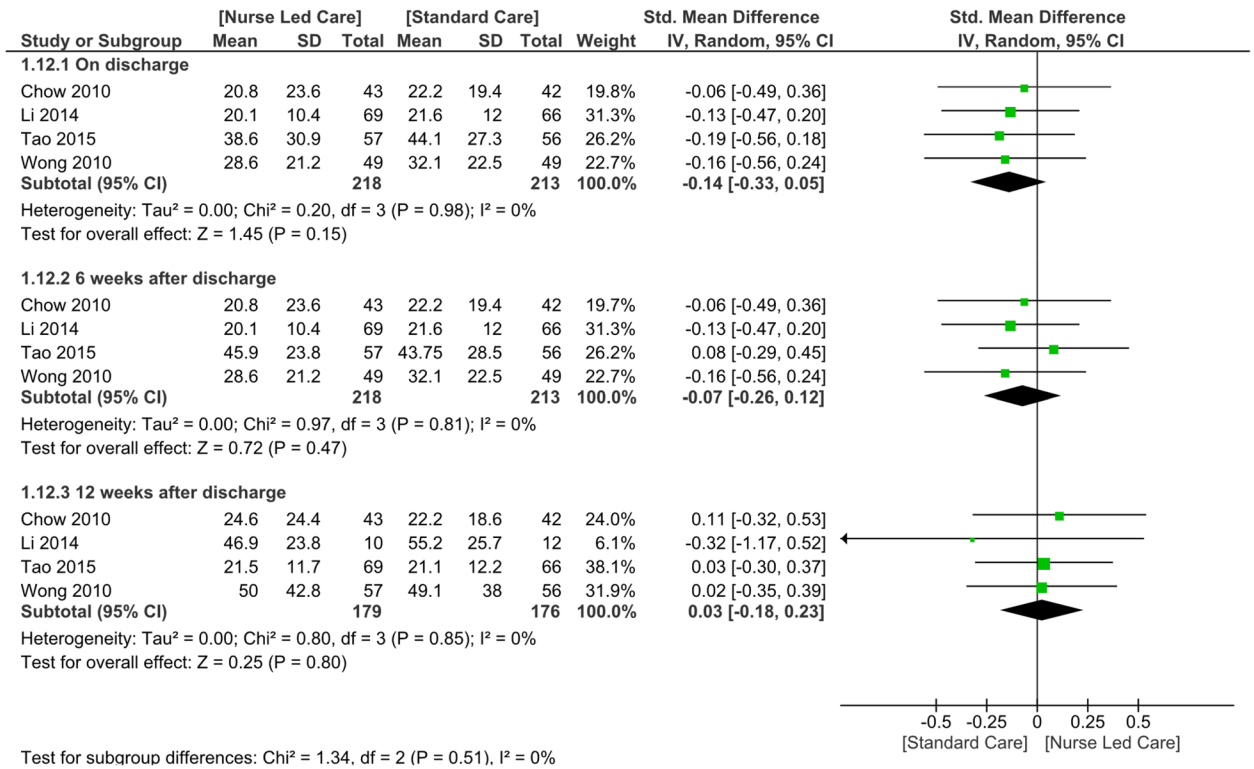

Fig. 6 Forest plot comparing burden of kidney diseases (Excluding High-Risk Study)

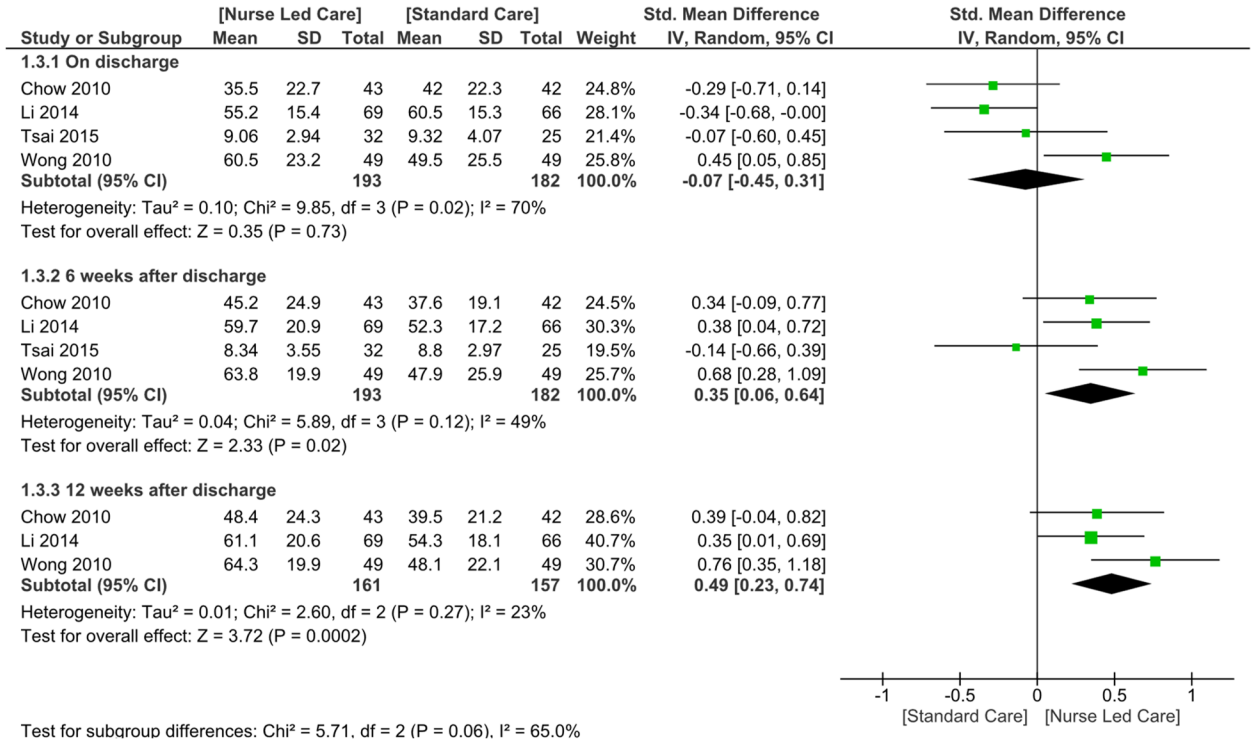

Fig. 7 Forest plot comparing sleep

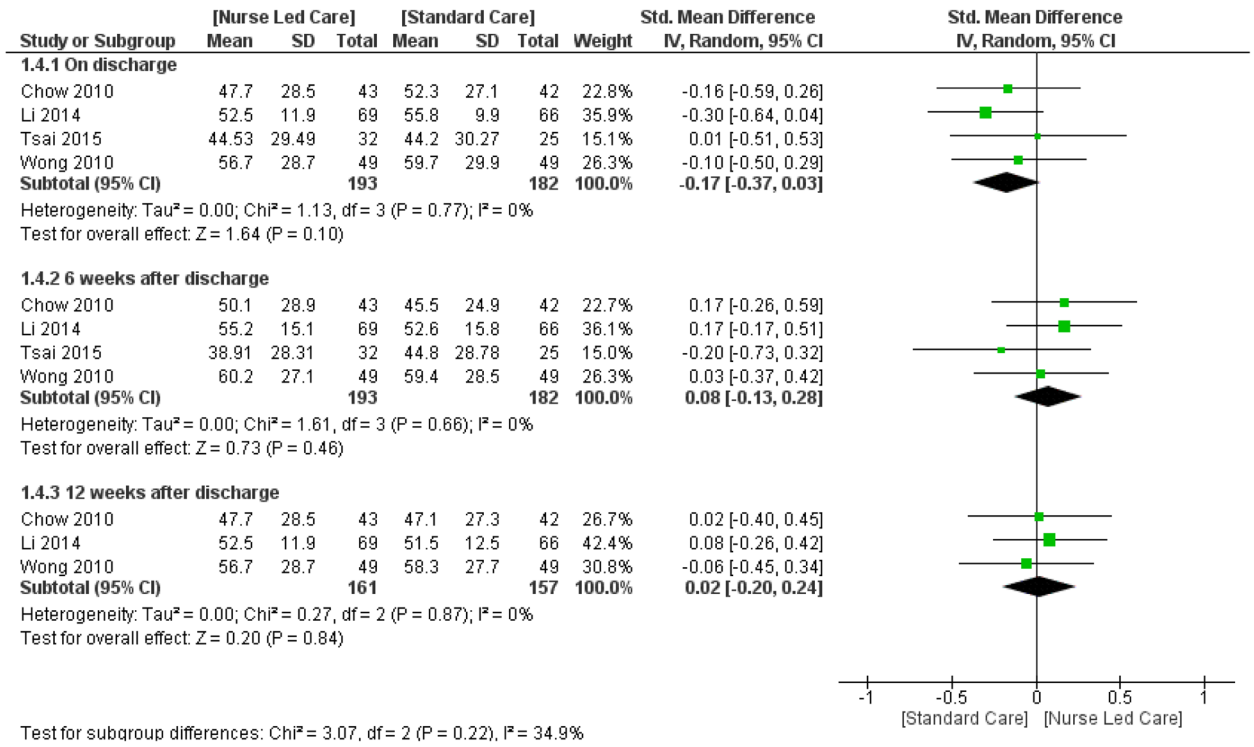

Fig. 8 Forest plot comparing physical functioning

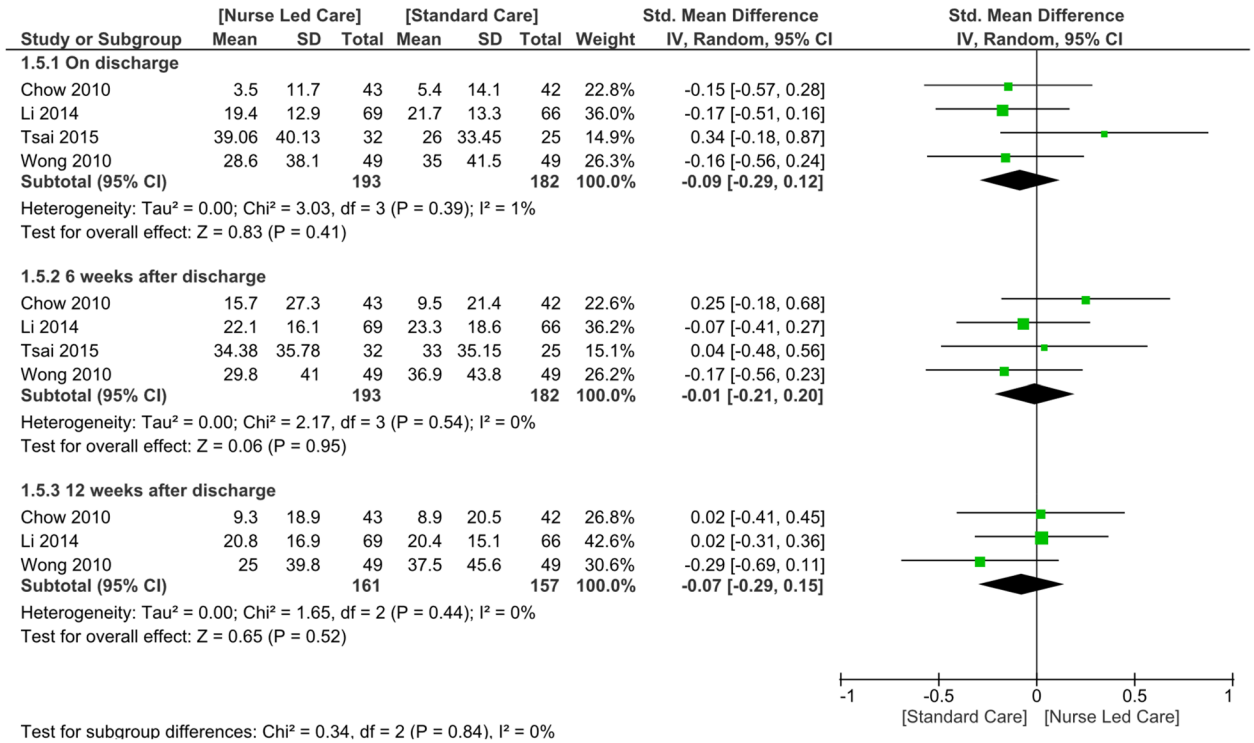

Fig. 9 Forest plot comparing role- physical

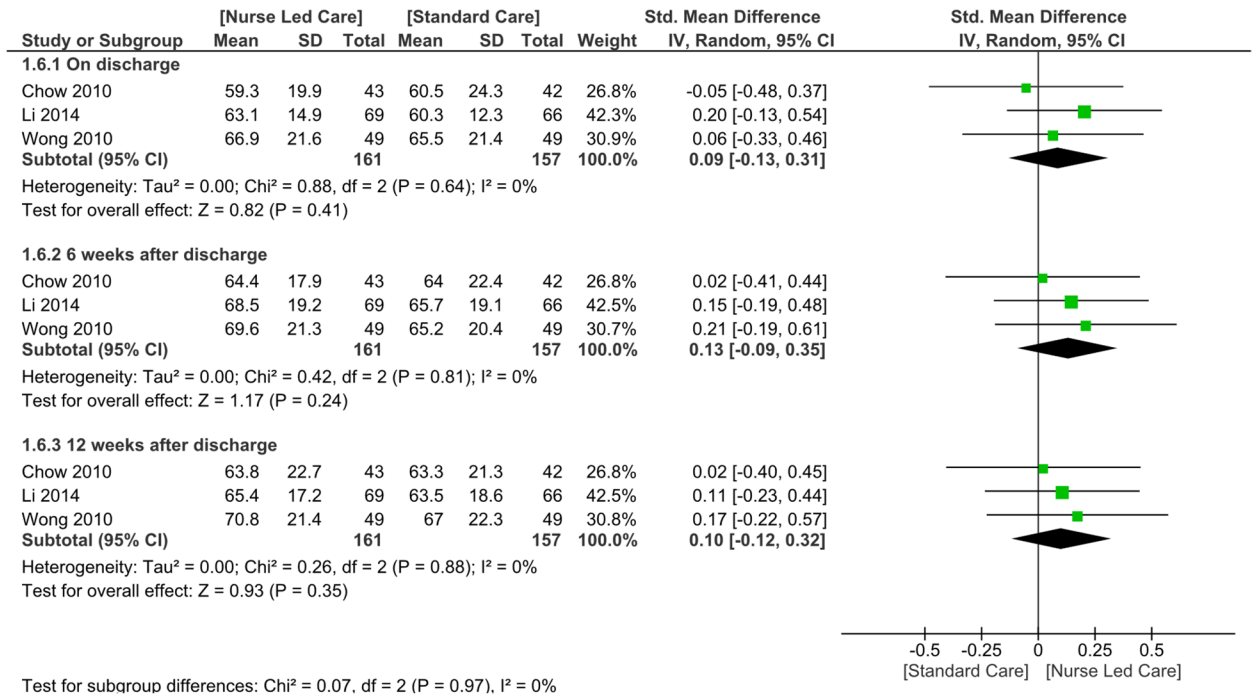

Fig. 10 Forest plot comparing emotional well-being

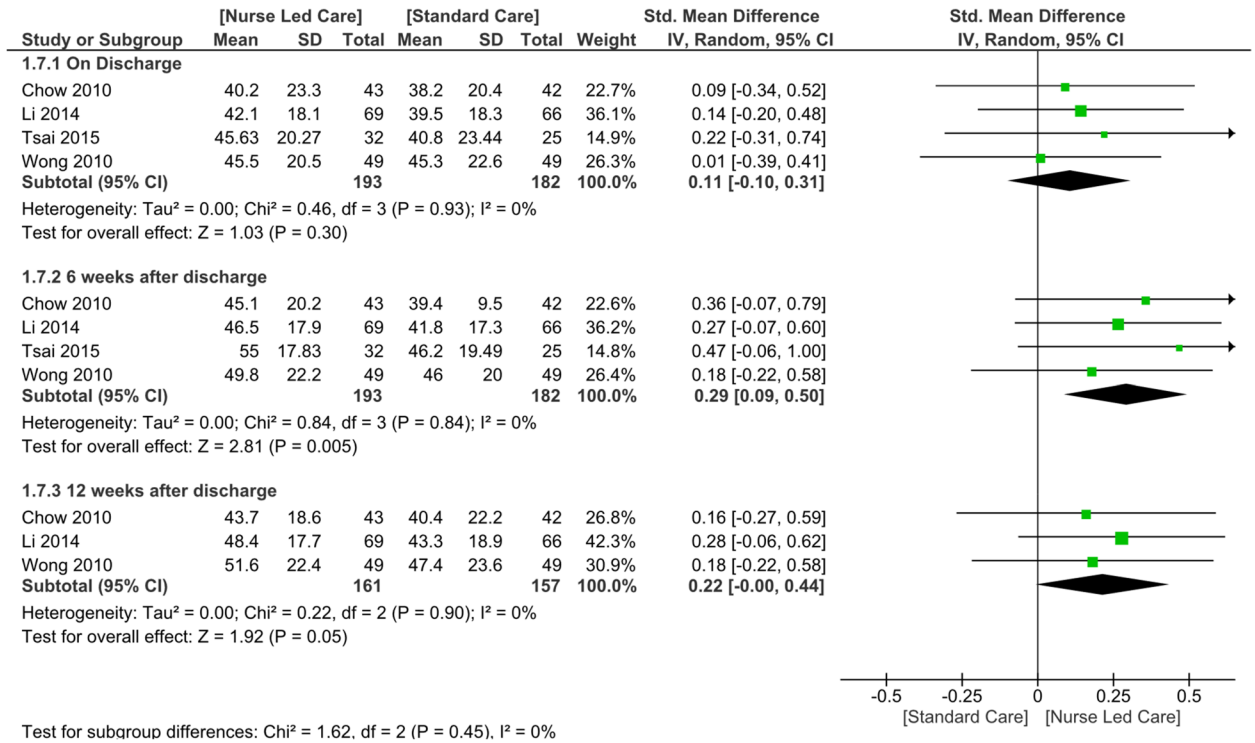

Fig. 11 Forest plot comparing energy/ fatigue

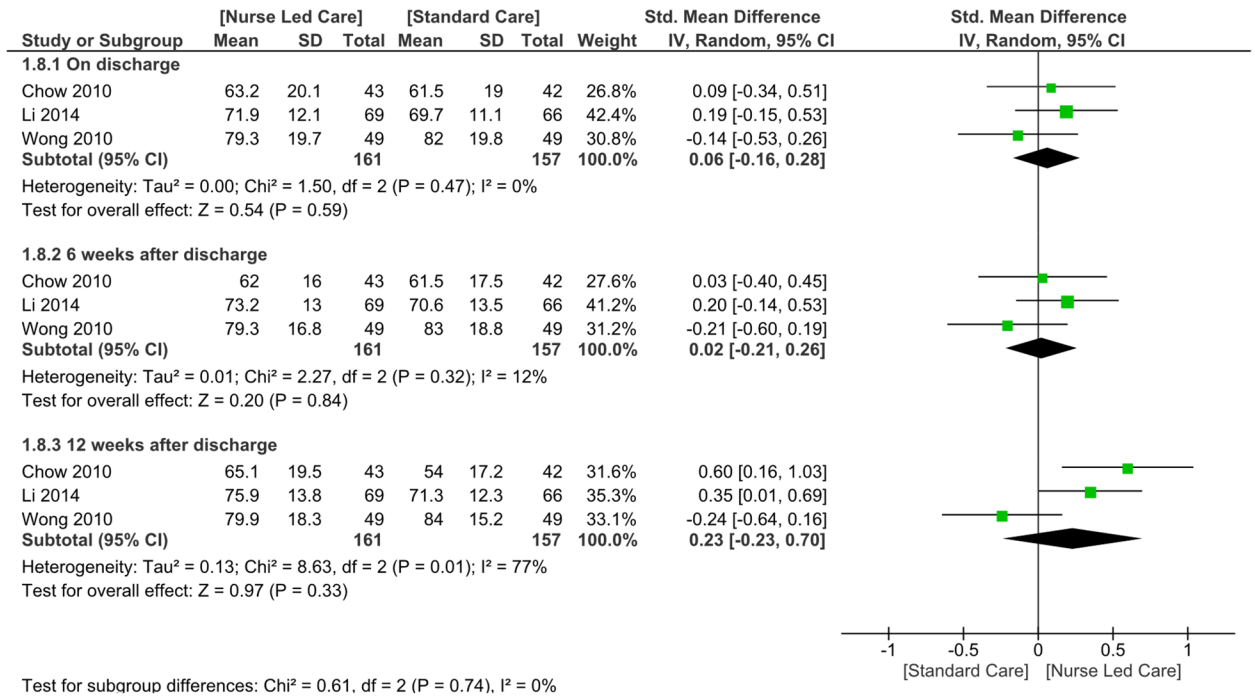

Fig. 12 Forest plot comparing patient satisfaction

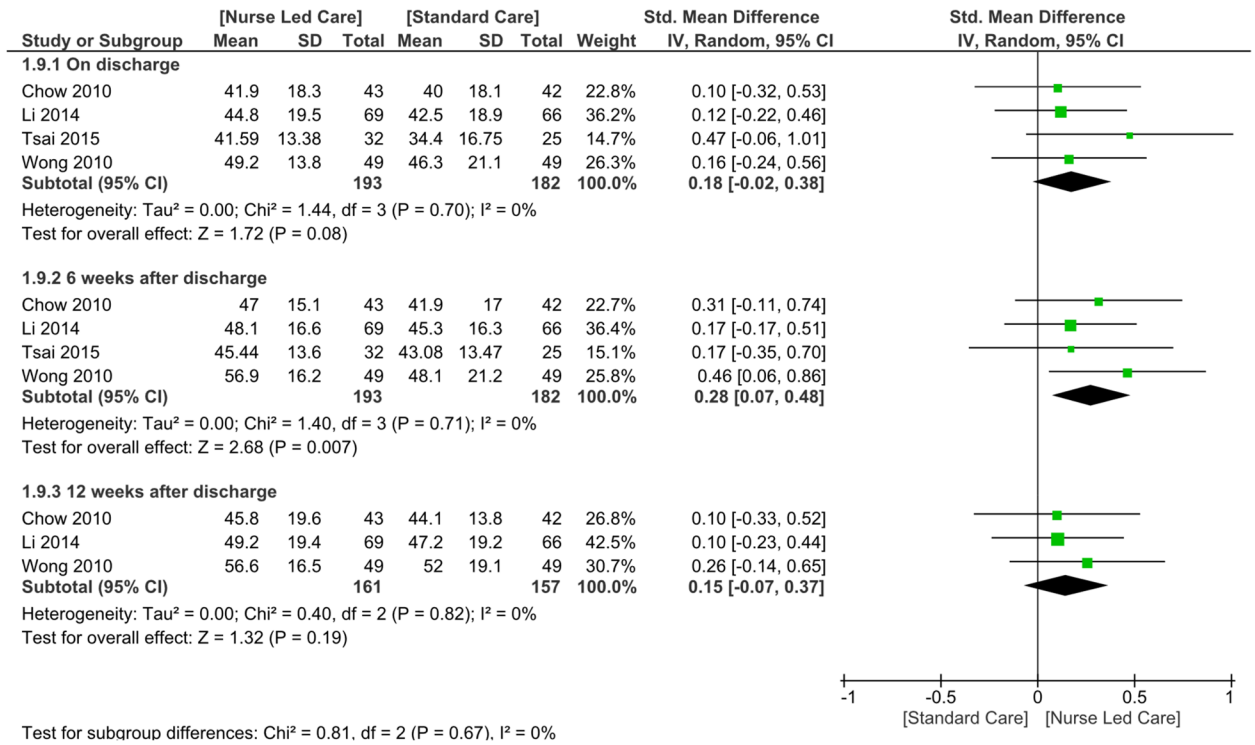

Fig. 13 Forest plot comparing overall health

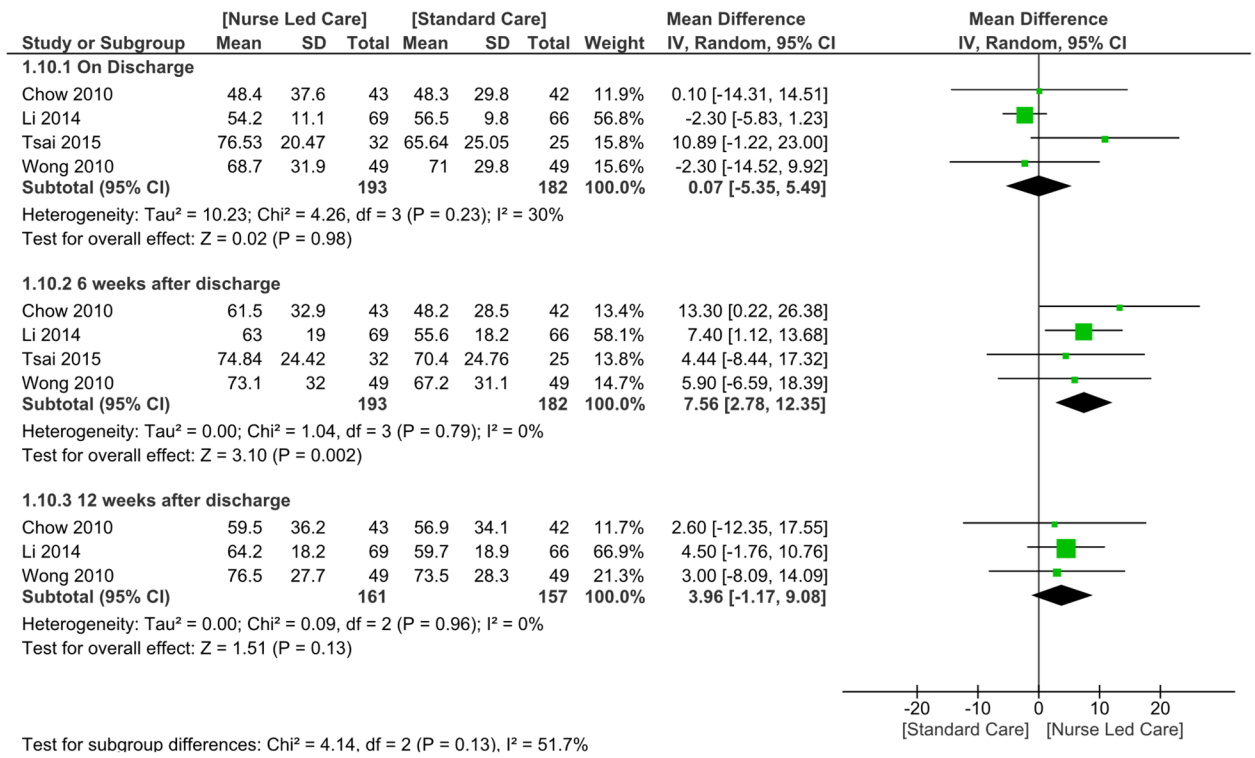

Fig. 14 Forest plot comparing pain

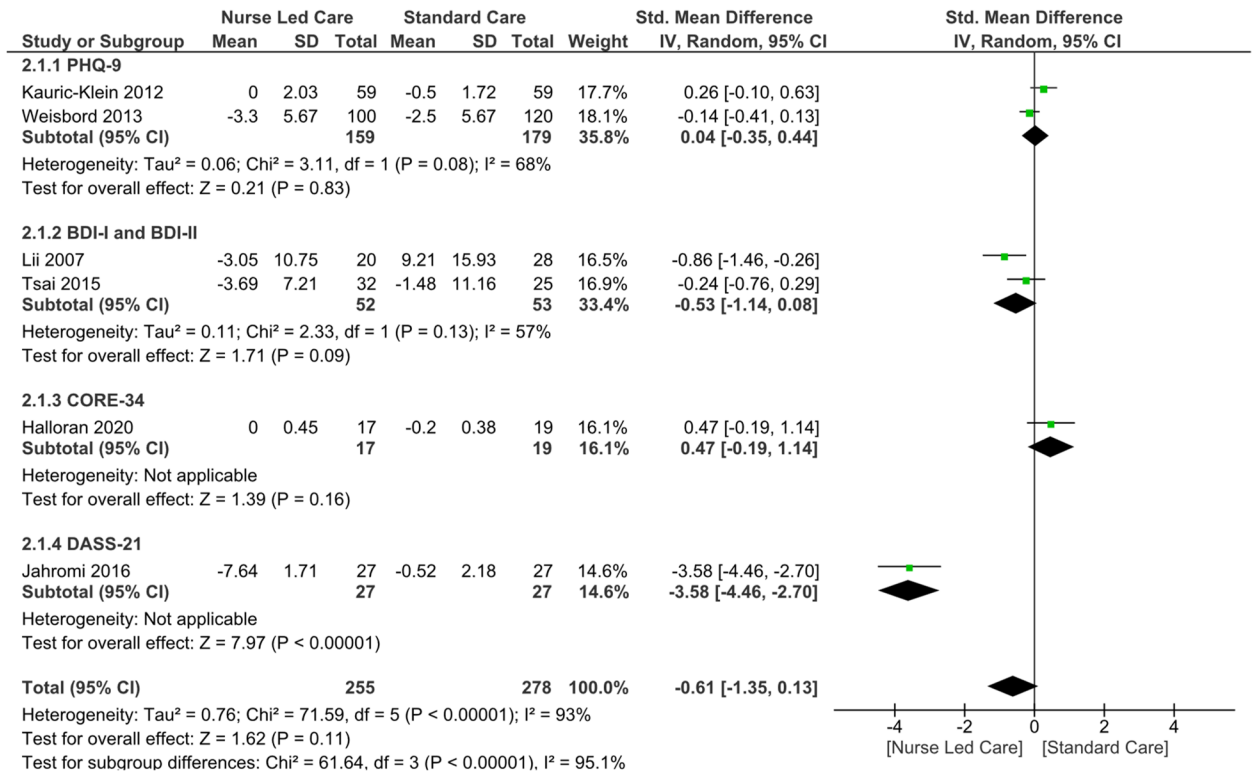

Fig. 15 Forest plot comparing depression

Discussion

This study specifically explores the effectiveness of nurse-led care in managing chronic kidney disease (CKD), focusing not only on the clinical outcomes but also on the broader impact on patients' physical, social, and mental well-being, their coping strategies, and overall quality of life. Our investigation seeks to delve into several key inquiries. We aim to ascertain the extent to which nurse-led care interventions influence the progression of CKD and contribute to achieving desirable clinical outcomes, including physical and mental well-being.

Our analysis revealed that, although no significant improvements were observed in certain components of quality of life (such as work status, cognitive function, social interactions, sexual function, patient satisfaction, general health problems, and burden of kidney disease), nurse-led care interventions resulted in notable improvements in symptoms and issues directly associated with kidney disease. These findings are consistent with those of Chen et al., 2016 [17], who reported similar results in a smaller sample of three RCTs. Our study extends this evidence by incorporating additional trials, such as those by Halloran et al., 2020 [31] and Tao et al., 2015 [14], further supporting the positive impact of nurse-led care on managing CKD symptoms.

There was a consistent positive correlation observed between nurse-led care and improved sleep among CKD patients (Fig. 7). The systematic review by Chen et al., 2016 [17] reported a similar outcome, though it didn't incorporate the findings from Tsai et al., 2015 [22] as this RCT was published after their review. This highlights the ongoing relevance of new studies and suggests that including more recent data could further strengthen the understanding of nurse-led care's impact on sleep. All four studies included in this meta-analysis unanimously proved the efficacy of nurse-led interventions in addressing sleep disturbances commonly experienced by CKD patients. It's also important to note that the effects of interventions increased over time. The most recent study by Hu et al., 2022 [34] also supported these findings; however, it was later retracted and therefore not included in this meta-analysis. Sleep quality is a critical aspect of overall health and well-being, with improvements in this area potentially leading to significant implications for patient outcomes, including enhanced quality of life and better disease management.

This meta-analysis did not reveal any statistically significant improvement in physical functioning and role-physical by nurse-led care administration (Figs. 8 and 9). These findings suggest that while nurse-led interventions may play a crucial role in addressing certain aspects of CKD management, they may not have a substantial impact on improving physical role functioning or overall physical functioning in CKD patients. An RCT by Hu et al., 2022 [34] reported a significant improvement in physical functioning after the nurse-led care intervention in the experimental group but its retraction leaves the results questionable and opens the room for further exploration.

No statistically significant correlation could be noted between nurse-led care administration and emotional well-being (Fig. 10) or satisfaction levels (Fig. 12) among CKD patients. However, statistically significant reductions in Self-Rating Anxiety (SAS) and Self-Rating Depression (SDS) scores were reported by Hu et al., 2022 [34] and Chen et al., 2022 [35] after the administration of nurse-led psychological care. Despite these studies initially demonstrating substantial improvements in the psychological well-being of CKD patients, their subsequent retraction has invalidated these findings. Further research is necessary to comprehensively investigate the impact of nurse-led interventions on psychological and emotional well-being among CKD patients.

Significant improvements in energy levels/fatigue, and overall health outcomes were observed (Figs. 11 and 13), as reported earlier by Chen et al., 2016 [17] as well. However, Chen et al., 2016 [17] did not take into account the loss to follow-up in Li et al., 2014 [13] and mistakenly considered the sample size to be 80 instead of 69 and 66 in intervention and control groups respectively. This highlights the potential of nurse-led care models to positively impact the holistic health of CKD patients by providing comprehensive care, lifestyle modifications, and patient education.

Although the results indicate nurse-led intervention practices to be effective in improving quality of life, different studies reported it to negatively impact kidney function. According to Haan et al., 2013 [32] and Nguyens et al., 2019 [27], standardized nephrologist-led care is more impactful than nurse-led care in lowering BP among CKD patients. These studies provided a follow-up of 1 year and 16 weeks respectively but Major et al., 2019 [23] followed patients for 42 months and reported the opposite. It is not clear that the problem lies in the intervention, or the follow-up period was not adequate to draw a significant conclusion. Further investigation is necessary to clarify these inconsistencies and determine the most effective approach for managing CKD patients.

This study represents a significant breakthrough in uncovering a previously unexplored outcome: depression. The research consistently observed a notable decrease in depression scores among patients under nurse-led care (Fig. 15). However, the effectiveness varied across different measurement scales used in the studies. For instance, Lii et al., 2007 [33]; and Tsai et al., 2015 [22] utilized Beck's Depression Inventory (BDI and BDI-II),

and showed a non-significant improvement in depression by the intervention of nurse-led care. In contrast, studies by Kauric-Klein et al., 2007 [19] and Weisbord et al., 2013 [21] used the Patient Health Questionnaire (PHQ-9) and they concluded no significant association. Halloran et al., 2020 [31] found no significant difference between both groups using Clinical Outcomes in Routine Evaluation (CORE-34), while Jahromi et al., 2016 [25] concluded an extreme level of statistically significant improvement in depression by the nurse-led care intervention. The inconsistency among assessment tools highlights the intricacy of evaluating depression and indicates a need for a more uniform methodology.

Notwithstanding these discrepancies, it's crucial to examine why interventions led by nurses may have such beneficial effects on mental well-being. Care provided by nurses typically encompasses a comprehensive strategy, not only managing the physical aspects of long-term illnesses but also offering emotional backing, instruction, and empowerment, which are vital in addressing depression. The regular patient interactions and personalized care in nurse-directed models may cultivate a therapeutic bond that motivates patients to become more engaged in their treatment, potentially enhancing mood and diminishing feelings of powerlessness. Moreover, nurses' involvement in mental health education and the application of coping techniques may assist patients in handling stress, a significant factor contributing to depression in chronic conditions. This integrated approach could account for the noted improvements in depression scores, though additional research is necessary to pinpoint the specific components of nurse-led care that are most effective in alleviating depressive symptoms.

Moreover, some other outcomes have also been reported by various studies. Even those not eligible for meta-analyses provide valuable insights. Fishbane et al., 2017 [30] reported that nurse-led interventions were effective in reducing hospitalization rates. Arad et al., 2021 [20] and Jadhav et al., 2018 [28] successfully developed nurse-led patient education programs that improved treatment and medication adherence among CKD patients. Shi et al., 2013 [24] demonstrated better control of hyperphosphatemia in the experimental group. Conversely, Zuilen et al., 2012 [16] and Barrett et al., 2011 [15] concluded that nurse-led interventions did not significantly impact cardiovascular outcomes and eGFR (estimated glomerular filtration rate) in CKD patients, respectively.

Our study did not specifically aim to assess patient empowerment as a primary outcome. However, we acknowledge that nurse-led care often includes empowering patients to take an active role in managing their condition. While our results demonstrated significant improvements in symptoms and problems associated with kidney disease (Fig. 3), sleep quality (Fig. 7), energy/fatigue (Fig. 11), pain (Fig. 14), depression (Fig. 15), and overall health (Fig. 13), no significant improvements were found in certain components of quality of life, such as work status, cognitive function, quality of social interactions, sexual function, patient satisfaction, social function etc. These findings suggest that nurse-led care may have a positive impact on symptom management, but further research is warranted to explore its role in enhancing patient empowerment and other psychosocial aspects of CKD management.

Our findings align with previous systematic reviews [36], which have consistently shown that the inclusion of advanced practice nurse practitioners (ANPs) in healthcare management has positive effects on various health parameters.

This systematic review and meta-analysis was initiated to evaluate recent RCTs to better define the pros and cons of nurse-led interventions among CKD patients. However, the retraction of some studies was a major setback, limiting the pool of available data. Zheng et al., 2022 (37) found nurse-led care to help improve self-efficacy, medication adherence, and quality of life among CKD patients. Chen et al., 2022 [36] reported its efficacy in enhancing vitality, quality of life, patient satisfaction and treatment compliance. Additionally, they found it useful in reducing physical pain, postoperative complications, anxiety, and depression. Hu et al., 2022 [35] observed that while nurse-led care improved the nutritional status of CKD patients, it severely compromised renal function.

Our findings provide important insights into nurse-led care impact on patient well-being. We found that nurse-led care significantly improved symptoms and problems commonly associated with CKD, including sleep quality, energy levels, and depression. Additionally, the overall health of patients showed notable improvement. However, nurse-led care did not significantly impact kidney disease burden, physical functioning, or emotional well-being. Variability in depression outcomes suggests potential heterogeneity across studies. While some trials reported improvements in hospitalization rates and treatment adherence, the results were inconsistent, highlighting the need for more rigorous research to better define the comprehensive efficacy of nurse-led care. Although our study did not measure outcomes such as blood pressure (BP), low-density lipoprotein (LDL) levels, parathyroid hormone (PTH) levels, or phosphate control, previous research has demonstrated that ANP involvement has led to improvements in these areas. Thus, our results, in conjunction with prior findings, reinforce the beneficial role of ANPs in healthcare management.

Limitations

The timing of intervention is a critical factor that can influence outcomes in patients with CKD. In this study, we did not stratify interventions based on the stage of disease progression, which may affect the comparability of results. Future research should aim to analyze interventions across different stages of CKD, including at the point of diagnosis, during long-term management, and at end-of-life care. Less evidence is available for certain outcomes like mortality, hospitalization rate, self-efficacy, compliance, and renal parameters. The majority of studies included were conducted in Eastern countries, particularly Asia, where healthcare systems and cultural norms differ significantly from those in Western regions. This geographic concentration may limit the generalizability of findings, as the effectiveness and implementation of nurse-led care models could vary in different healthcare contexts. Future research should explore these interventions in diverse regions to validate their broader applicability. Only a few studies could follow-up for the long term and that too reported results at variable times. 5 out of 10 studies included in meta-analysis had a high risk of bias which might affect the reliability of findings. Moreover, future research should incorporate clinical relevance measures to better understand the practical impact of nurse-led care interventions on patient outcomes, ensuring that observed improvements translate into meaningful benefits for patients' daily lives.

Practical implications

Our findings contribute to the growing body of evidence supporting the effectiveness of nurse-led care in improving patient outcomes and enhancing the quality of life for CKD patients. These results have important implications for clinical practice, emphasizing the integration of nurse-led interventions into CKD care pathways to optimize patient-centered care and improve health outcomes. A comprehensive nurse-led intervention program should be devised for CKD patients. Telephone follow-up, social support, and patient education should be the main focus of this holistic approach to improving the health and quality of life of this population. Adequate training and continuous professional development are imperative for nurses to effectively manage chronic kidney disease, thereby ensuring that the quality of care aligns with established healthcare standards.

Conclusions

Although a great deal of evidence supports the effectiveness of nurse-led care in improving quality of life, sleep, pain, overall health and depressive symptoms among CKD patients. Certain domains such as hospitalization rates, mortality, and compliance remain under-investigated. More trials and qualitative studies are required to fully understand the overall effects of nurse-led interventions in CKD care, as their impact on renal function remains in question.

Abbreviations

CKD	Chronic Kidney Disease
RRT	Renal Replacement Therapy
RCTs	Randomized Controlled Trials
eGFR	Estimated Glomerular Filtration Rate
RevMan	Review Manager
STATA	Statistics and Data
HD	Hemodialysis
PD	Peritoneal dialysis
HbA1c	Hemoglobin A1C (Glycated hemoglobin)
PRISMA	Preferred Items for Systematic Reviews and Meta-Analysis
MeSH	Medical Subject Headings
BP	Blood Pressure
OR	Odds Ratio
SMS	Short Message Service
Fe	Iron
RAAS	Renin Angiotensin Aldosterone System
LDL	Low Density Lipoprotein
IMPAKT	Improving Patient Care and Awareness of Kidney Disease Progression Together
NICE	National Institute for Health and Care Excellence
ACEIs	Angiotensin Converting Enzyme Inhibitors
ARBs	Angiotensin Receptor Blockers
KDQoL	Kidney Disease Quality of Life
ACP	Advance Care Planning
ADRT	Advanced Decision to Refuse Treatment
DNR	Do Not Resuscitate
ANPs	Advance Nurse Practitioners
PTH	Parathyroid hormone
DASS	Depression Anxiety Stress Scale
BDI	Beck's Depression Inventory
CORE-34	Clinical Outcomes in Routine Evaluation
SAS	Self-Rating Anxiety
SDS	Self-Rating Depression
SEM	Standard Error of Mean
CI	Confidence Interval
NC	Nurse-led care group
SC	Standard care group

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s12912-025-02829-z.

Supplementary Material 1.

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Not applicable

Authors' contributions

MUH conceived the study. HA and MUH generated search strings and imported the articles to Covidence. MA registered protocol on PROSPERO with the help of KF and NA. HA, MUH, MA, ZN, MZ, NA, and KF screened articles. HA developed a data extraction sheet and all of the authors contributed to data extraction. MUH and HA decided the outcomes and performed the meta-analysis. All of the participants contributed to manuscript writing.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate
Not applicable.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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