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Nurse-led care versus usual care on cardiovascular risk factors for patients with type 2 diabetes: a systematic review and meta-analysis

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ABSTRACT

Objects This study aims to systematically evaluate the effectiveness of nurse-led cares on cardiovascular risk factors among individuals with type 2 diabetes mellitus.

Design Systematic review and meta-analysis.

Methods The electronic databases PubMed, EMBASE, CINAHL and Cochrane Library databases were searched for randomised controlled trials of nurse-led care for individuals with type 2 diabetes mellitus (T2DM) published in English from inception to 23 December 2021. Random effects models were used to calculate weighted mean differences (WMD) with 95%CI.

Results 13 articles were included in the meta-analysis, with a total of3757 participants. Considering baseline measurements, pooled analysis showed that nurse-led care significantly decreased the glycosylated haemoglobin (HbA1c) (WMD=−0.68 mmol/L; 95% CI −0.85 to −0.52; p<0.001), body mass index (BMI) (WMD=−0.54 kg/m^2; 95% CI: −0.97 to −0.11; p=0.01) and systolic blood pressure (SBP) (WMD=−1.17 mmHg; 95% CI: −2.11 to −0.22; p=0.02) for patients with T2DM. But there was no difference in low-density lipoprotein cholesterol (LDL-c) (WMD=−2.50 mg/dL; 95% CI: −5.07 to 0.08; p=0.06) between the nurse-led and control groups.

Conclusion Nurse-led care is an effective and accessible intervention that could improve HbA1c, SBP, BMI levels among individuals with T2DM.

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Strengths and limitations of this study

- ► This review provided a comprehensive assessment of the impact of nurse-led care in patients with type 2 diabetes.
- ► We use conservative selection methods to minimise erroneous potentially relevant research.
- ► Since strict inclusion and exclusion criteria, potential selection bias was minimised.
- ► Substantial heterogeneity was observed in these studies.

INTRODUCTION

The increasing incidence of type 2 diabetes mellitus (T2DM) has significant implications for healthcare management. According to the WHO, there are currently more than 463 million T2DM globally.[1] T2DM is associated with several complications,[2] in which cardiovascular complications are the main leading of mortality.[3–6] The incidence of myocardial infarction and sudden death in T2DM was the same as in patients with coronary heart disease.[7 8] Therefore, it is crucial to control the cardiovascular risk factors for patients with T2DM.

Previous studies[9 10] have shown that most patients with T2DM were under the management of physicians, which has led to a gradual increase in pressure workload for physicians. Hence, many investigators extended the role of nurses as case managers.[11] To meet changing clinical requirements, nurses, may pick a certain number of patients that could be independent within the advanced practice, and thus relieving the stress within medical clinics.[12] There were mounting evidences[13–17] indicating that nurse-led diabetes management programmes could provide more comprehensive care, including the guidance of diet, symptom management, lifestyle changes, psychological support and diabetic education, which could prevent or postpone the complications of diabetes. However, disputable conclusions remained existing in different studies. For example, a study conducted by Tang *et al*[18] showed a great reduction in glycosylated haemoglobin (HbA1c) with an intervention period of 6 months, but no difference for 12 months (p=0.133). Morgan *et al*[19] found that HbA1c in both experimental groups was remarkable decrease deduced (p=0.049). Vos *et al*[20] reported there was no significant difference between the nurse-led and control groups. The inconsistency of these studies has impeded the nurse-led practice in clinical settings. Furthermore, several trials published recently require updated synthesis

of evidence. Therefore, we conducted a systematic review and meta-analysis to evaluate the impact of a nurse-led interventions programme versus usual-care on patients with T2DM and provide trustworthy practice guidelines on newly released evidence.

METHODS

This systematic review was registered on PROSPERO, and conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses Recommendations project.[21] We devised research questions using the Population/Intervention/Comparison/Outcome (PICO) framework for systematic review: for patients with T2DM (participants), nurse-led diabetes education (intervention), cardiovascular risk factors outcomes (outcomes) for the intervention group than the usual care group (comparison) in randomised controlled trials (RCTs) (type of studies). We defined nurse-led care[22] as that a nurse played a central role during T2DM management, such as follows up with patients, monitoring blood tests results and providing continuous education.

Data sources and searches

The literature search was conducted in PubMed, Embase, CINAHL and the Cochrane Central Register of Controlled Trials until 27 April 2021. The search strategy was updated on 23 December 2021. We used the following MeSh terms in combination using AND or OR: 'Diabetes Mellitus, Type 2', 'noninsulin-dependent diabetes mellitus', 'Practice Patterns, Nurses', 'Nursing Practice'. We limited the search language to English. We also searched the reference list of previous reviews related to this systematic review and contacted the study authors for more data when required (The searching strategy is in detailed in online supplemental file 1).

Study selection

To be included in this review, studies had to meet all the following criteria: (1) RCTs; (2) had at least one of cardiovascular risk factors for diabetes as an outcome; (3) written in English; and (4) had more than 6 months of follow-up. Trials were excluded if (1) the intervention was delivered by other healthcare providers; (2) duplicate publications.

Outcomes

The outcome should include any cardiovascular risk factor such as HbA1c, systolic blood pressure (SBP), low-density lipoprotein cholesterol (LDL-c) and body mass index (BMI), or any combination of these.

Data extraction and quality assessment

Two reviewers (JZ and XZ) worked independently to scan and evaluate full text for eligible studies according to the criteria of inclusion. The third reviewers (CL and YD) resolved disagreements by discussion. Relevant data included: (1) author, publication year, country; (2) delivery setting, age, sample size, length of follow-up; (3) description of interventions, outcomes, and the outcomes with mean and SD checked for accuracy. All data were collated and imported to a statistical evaluation programme (Microsoft Excel) and prepared for analysis.

The Cochrane risk-of-bias tool[23 24] was used to evaluate the bias of randomised studies. Allocation concealment, random sequence generation, blinding of participants, personnel and outcome assessors, selective reporting of outcomes, and incomplete outcome data were carefully evaluated.

Data synthesis and analysis

For the statistical analysis,[25] the Review Manager (V.5.4.0) and Stata MP V.16.0. software were used. We have calculated weighted mean differences (WMD) with 95% CI. Heterogeneity was evaluated by χ^2 test and corresponding p value to assess the dispersion of the actual effect among the included studies. I^2>50% was considered high heterogeneity (random effects model was used), and values lower than 50% to indicate low heterogeneity (fixed effects model was used).[26 27] To further explore the effect of different delivery settings, we conducted a subgroup analysis of the factors that may lead to heterogeneity. A sensitivity analysis was performed to explore the effect of each study on the overall pooled estimate. We used funnel plot to detect the publications bias. Trim and fill method will be used to adjust the publication bias if it exists.[28] P value<0.05 indicated a statistically significant difference.

Patient and public involvement statement

The proposed study does not involve patients and the public in the design, or conduct, or reporting, or dissemination plans. Accordingly, no patient and public involvement statement is required.

RESULTS

Searching process

A total of 2455 articles were retrieved. After the removal of duplicates, 1589 articles were retained for abstract and title screening. Initial screening excluded 1403 articles; only 186 articles remained for full-text screening. Further, 173 articles were excluded due to various reasons such as non-nurse-led (n=59), non-eligible population types (n=26), less than 6 months of follow-up (n=18), conference abstract (n=15), non-English articles (n=10), not RCTs (n=13), duplicate reporting (n=9), unrelated to the predecided outcomes (n=2), study protocol (n=9), ongoing study (n=4), dissertation (n=1), not relevant (n=1) and no sufficient data (n=6). So, only 13 studies were eventually left for this analysis. The process of screening was displayed in figure 1.

Characteristics of the studies included

Characteristics of included trials and patient characteristics at baseline were shown in table 1. Of the 13 studies, two were from the USA, and the others were from Australia, Netherlands, South Korea, Dutch, Iran,

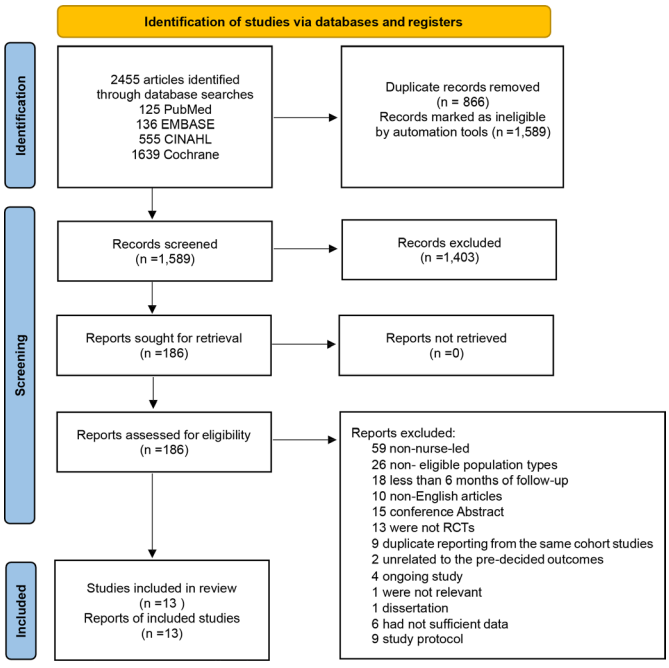

Figure 1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram showing study selection. RCTs, randomised controlled trials.

Sri Lank, Northern Sweden, China, Italian, Belgium, and the UK. Care settings and intervention modalities were conducted including remote delivery,[18 29–31] clinical care[14 20 32–35] and primary care.[19 36 37]

Nurse-led care program of included trials

All studies clearly described programmes in nurse-led intervention, such as treatment of case group, intervention methods, practice recruitment and length of follow-up. The interventions were distributed including structured diabetes education,[33–36] trueBlue collaborative care,[19] telecoaching,[30 31] online disease management,[18] short message service (SMS) programme,[29] beyond good intentions programme[20] and the diabetes self-management education/diabetes self-management (DSME/DSM) programme.[14 32 37] All studies reported that nurses played a leading role in the entire intervention process. The interventions components were consisted of the face-to-face session, multiple group sessions and online consulting service. All selected patients received exercise management, blood glucose monitoring, psychological adjustment, drug therapy and training of insulin injection technology. In two studies,[14 37] patients received multidisciplinary team management including endocrinologists, nutritionists, nurses and pharmacists, in which the actual intervention to be carried out by a nurse. In 11 studies, patients received education from different types of nurses[18–20 29–36] such as practice nurses, primary care nurses, nurse care managers and community nurses.

Methodological quality assessment

The eligible studies included 13 RCTs, and the seven items of e Cochrane Handbook V.5.1.0 assessed the quality of these included studies. The methodological quality of studies included was fairly good to moderate, as shown in figures 2 and 3. Sensitivity analyses would be employed to assess the susceptibility of the findings of this meta-analysis. Which would be carried out by sequential omission of each study and evaluate the effect size changed. We used mention menu in Stata/MP V.16.0 to conduct sensitivity analyses. The study by Weinberger *et al*[30] has the most significant impact on the result of meta-analysis. However, its upper limit of 95% CI did not exceed 0. Other studies have no significant changes on the effect size if omitted. This ascertained the robustness of the findings (online supplemental file 2).

Publication bias detection

We used funnel plot to assess the potential publication bias. Asymmetry was found through eyeballing the funnel plot. A trim-and-fill method was applied to estimate and adjust asymmetry in the funnel plot. After filling the right side of the funnel plot, no new studies were imputed and the effect size with confidential interval did not show any significant change, which verifies that the conclusion of this study will not be affected by publication bias (online supplemental file 3).

Meta-analysis

Hemoglobin A1c

Twelve trials had investigated the effects of nursing intervention on HbA1c. Nurse-led intervention lowered HbA1c compared with usual care (WMD=−0.68 mmol/L; 95% CI: −0.85 to −0.52; p<0.001) (figure 4A). Meanwhile, we compared the glycation status of the two groups after the intervention, meta-analysis revealed that compared with usual care, nurse-led care also has a positive impact on HbA1c (WMD=−0.58 mmol/L, 95% CI: −0.73 to −0.43; p<0.001) (online supplemental file 4).

Subgroup analysis was performed based on different delivery setting (online supplemental file 5). All studies in clinical setting (WMD=−0.83 mmol/L; 95% CI: −1.28 to −0.37, p<0.001), primary care setting (WMD=−0.62 mmol/L; 95% CI: −1.11 to −0.14, p=0.01) and remote delivery (WMD=−0.58 mmol/L; 95% CI: −0.94 to −0.21, p=0.002) showed a greater mean reduction in HbA1c.

Body mass index

Nine trials had investigated the effects of nursing intervention on BMI. In the pooled analysis, compared with nurse-led interventions, significant mean difference for BMI was observed for usual care (WMD=−0.54 kg/m^2; 95% CI: −0.97 to −0.11; p=0.01) (figure 4B). However, only two studies were conducted by Franciosi *et al*[33] and Odnoletkova *et al*[31] showed a significant difference between the groups over 6 months (p=0.030, p=0.003, respectively). BMI in other studies[14 19 20 32 34–36] had no significant difference between the groups (p>0.05).

Table 1 Characteristics of included studies

Study author	Year	Country	Sample size (n)	Delivery setting	Follow-up (month)	Mean age of usual care/ nurse-led (year)	Intervention team	Treatment of case group	Treatment of control group
Kim HS, et al[29]	2007	South Korea	51	Remote delivery	6	47.5±9.1/46.8±8.8	Nurse case managers; physicians	SMS	Usual care
Weinberger M, et al[30]	1995	USA	275	Remote delivery	12	63.2±8.3/63.9±8.6	Nurse case managers; physicians	Telephone intervention	Usual care
Vos RC, et al[20]	2019	Dutch	108	Clinial setting	30	61.7±7.4/62.9±8.3	Practice nurses; physicians	DSME	Usual care
Azami G, et al[14]	2018	Iran	142	Clinial setting	6	53.49±10.98/55.09±10.16	A multidisciplinary team including endocrinologists, nutritionists, nurses and pharmacists	DSME+MI	Usual care
Jayasuriya R, et al[32]	2015	Sri Lank	85	Clinial setting	6	51.4±7.1/51.5±7.5	Nurse case managers; physicians	DSM	Usual care
Hörnsten A, et al[36]	2005	Northern Sweden	104	Primary care setting	12	63.4±9.1/63.6±9.3	Diabetes nurses; physicians	Diabetes education	Usual care
Guo Z, et al[37]	2019	China	171	Primary care setting	12	64.35±7.07/63.12±8.02	A multidisciplinary team including community nurses, community doctors, clinical nursing specialist, diabetes specialists, nutritionist	NLTM	Usual care
Tang PC, et al[18]	2013	USA	415	Remote delivery	12	53.5±10.2/54.0±10.7	Nurse care managers; pharmacist; registered dietician	EMPOWER-D	Usual care
Franciosi M, et al[33]	2011	Italian	62	Clinial setting	6	48.7±0.6/48.9±0.5	Diabetes nurses; physicians	Disease management	Usual care
Jansink R, et al[34]	2013	Netherlands	940	Clinial setting	14	63.9±9.8/64.1±8.9	Primary care nurses; physicians	Lifestyle counselling	Usual care
Odnoletkova I, et al[31]	2016	Belgium	574	Remote delivery	18	62.4±8.9/63.8±8.7	Nurse case managers; physicians	COACH	Usual care
Al Lenjawi B, et al[35]	2016	UK	430	Clinial setting	12	55±9.7/52±8.9	Nurse educators; physicians	Theory-based educational	Usual care
Morgan MA, et al[19]	2013	Australian	400	Primary care setting	12	67.6±11.2/68.0±11.7	Practice nurses; physicians	TrueBlue model of collaborative care	Usual care

COACH, tele-education; DSM, diabete self-management; DSME, diabetes self-management education; EMPOWER-D, motivating patients online with enhanced resources for diabetes; MI, motivational interviewing; NLTM, nurse-led team management; SMS, short message service.

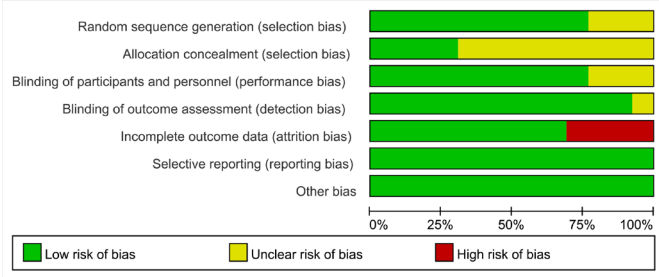

Figure 2 Risk-of-bias graph.

Low-density lipoprotein cholesterol

There was no significant mean reduction in LDL-c in eight trials for patients in the two group (WMD=−2.50 mg/dL; 95% CI: −5.07 to 0.08; p=0.06) (figure 4C) and heterogeneity was high (I^2=99%, p<0.001). A study by Jayasuriya *et al*[32] showed that a significant reduction in LDL-c in the 'usual care' group but not in the intervention group (p=0.082). Tang *et al*[18] reported that the invention group had significantly better management of LDL-c at 12 months (−6.1 mg/dL vs 0.0 mg/dL, p=0.001) than that in usual care. Vos *et al*[20] observed a decrease in LDL-c (p=0.01) in the intervention group compared with controls. Other studies showed there was no statistically significant difference in LDL-c between the two groups (p>0.05).

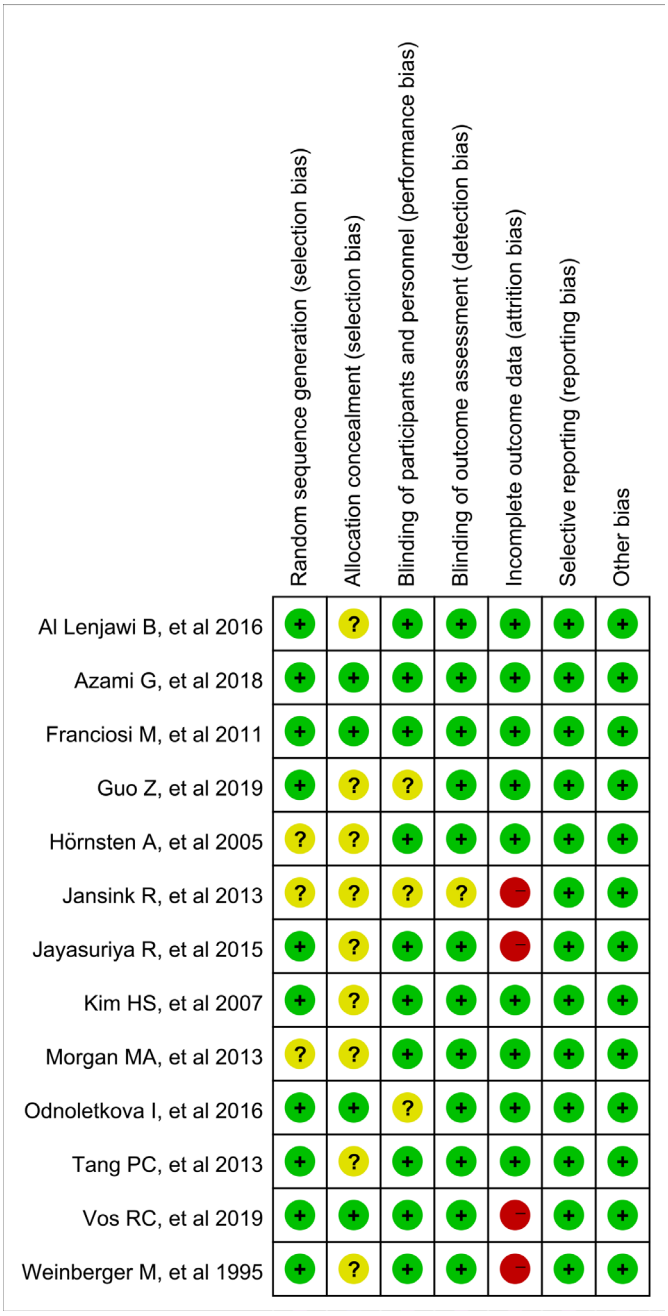

Figure 3 Risk-of-bias summary.

Systolic blood pressure

Of the 13 included studies, 9 investigated SBP levels as a primary outcome in T2DM.[14 18–20 31–35] Significant mean reductions were found for SBP (WMD=−1.17 mm Hg; 95% CI: −2.11 to −0.22; p=0.02) (figure 4D) in the nurse-led intervention group compared with patients who received usual care. Among these studies, two studies[14 32] reported that there was a slight improvement form baseline in SBP in the follows-up months in the experimental group when compared with the control group. Other studies[18–20 31 33–35] found that there was no significant difference in SBP between the groups (p>0.05).

DISCUSSION

Nurse-led care is associated with the better protocol compliance, the more regular follow-up, and could provide monitoring of serum chemistry as well as continuous patient education. Regardless of its diverse intervention such as DSME,[14] SMS,[29] telephone counselling[31] or nurse-led team management intervention,[37] their common feature are that they all emphasised the leading role of nurses as well as helping patients adhere to treatment plans from different perspectives. This meta-analysis evaluated nurse-led multiple interventions that targeted a wide range of cardiovascular risk factors in patients with T2DM and found that implementing nurse-led care could improve mean HbA1c, BMI, SBP levels in patients with T2DM. However, no improvements were observed in mean differences in LDL-c. The studies we included were from both developed and developing countries, and the participants came from different ethnicities, which may be a good representative worldwide.

HbA1c has been considered a vital element in the therapy of T2DM. Our study found that nurse-led care can improve patients' glycaemic control, which was consistent with the previous meta-analyses.[38–41] The United Kingdom Prospective Diabetes Study reported that for every 1% lower in HbA1c, microvascular complications would be reduced by 30%.[42] In the current study, the overall effect size was 0.68 of a SD improvement in HbA1c compared with usual care (figure 4A), which meant nurse-led diabetes care could alleviate glycaemic profiles and improve microvascular complications. Subgroup analyses revealed that the effect size of nurse-led programmes

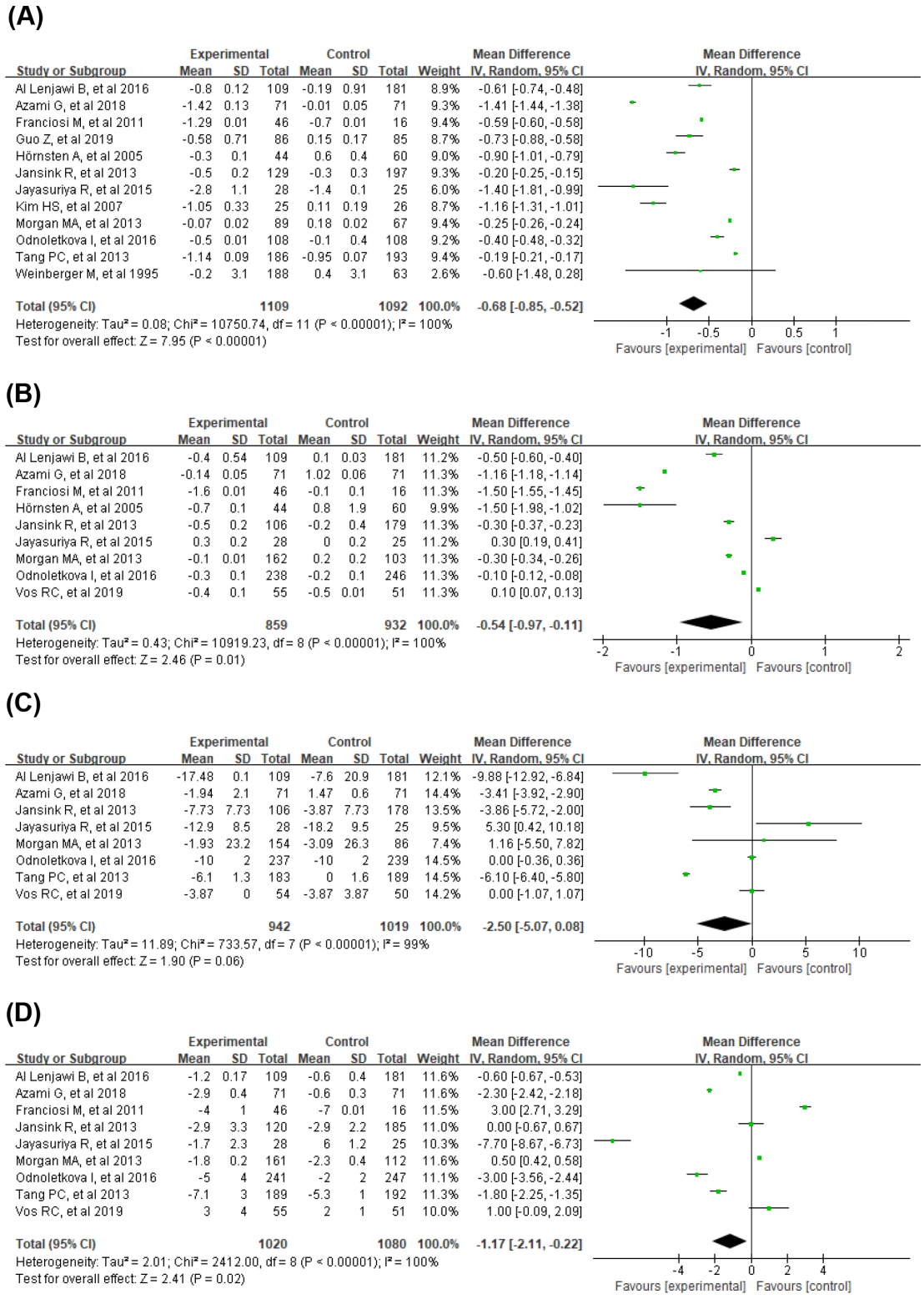

Figure 4 Comparison of the change scores of cardiovascular risk factors from baseline to follow-up. (A) Mean reduction in HbA1c (mmol/L). (B) Mean reduction in body mass index (kg/m^2). (C) Mean reduction in low-density lipoprotein cholesterol (mg/dL). (D) Mean reduction in systolic blood pressure (mm Hg).

had positive impacts on glycaemic control no matter in different delivery setting. Future research should focus on strategies for sustaining glycaemic treatment among nurse-led interventions effects in the long term.

The current study indicated significant weight reduction in the shorter duration (6–12 months) nurse-led care was in contrast with previous studies.[40 43] Obesity and overweight bring a huge financial burden to the individual. In

2014, impact of obesity on the global economic was estimated to be US$2.0 trillion of the global gross domestic product.[44] Meanwhile, nurse-led care was found to reduce healthcare costs and be cost-effective,[15 45] which indicates that nurses could greatly reduce the economic burden of patients with higher BMI levels through weight management. Lean *et al*[46] had proved that weight management was a lifelong behaviour that requires tailored and a strong focus on patient skills training over the patient's lifetime. In this perspective, the role of nurses is particularly important. Nurses participate in patients' treatment, which is the first step in weight loss. Therefore, our meta-analysis is the first we know to emphasise the impact of nurse-led care for at least 6 months duration of achieving remarkable weight loss in patients with T2DM.

Moreover, our results showed a remarkable reduction in SBP compared with usual care, which was consistent with a previous study.[39] For T2DM, higher SBP levels are associated with an increased risk of cardiovascular disease. Lower SBP inevitably have a greater impact on physical well-being in patient with T2DM.[47] A previous study report that higher baseline cardiovascular disease risk was associated with greater clinical benefit.[48] When the blood pressure drops to the target range, it is more difficult to continue to lower the blood pressure, so intensive nursing care is needed to help achieve the normal range.

The lack of an effect from nurse-led interventions on LDL-c in our study was in contrast to the finding of Niu *et al*.[43] It might because nurses in most countries are unable to prescribe and increase titration treatments, and they rely on physicians to play this role, which may hinder the development of nursing roles.[49–51] Improvement of LDL-c needs comprehensive strategies including drugs, diet change, exercise and may not easily be changed by single intervention. Results also suggest that longer-term follow-up education are needed to observe changes in LDL-c.[52]

Due to the new developments in the complexity of the disease, T2DM requires long-term care rather than intermittent treatment.[53 54] This highlights the necessity of nursing work, and nurses can provide guidance and advice to patients in terms of disease management, which could increase the patient's knowledge and self-efficiency. During the special period of the global novel coronavirus pneumonia epidemic, nurses from all over the world are actively responding to the country's call in the fight against the epidemic.[55] Before that, nurses perform a neglected human resource in China.[56] In order to improve understanding and respect for the nurse, we need to clearly define the role of nurses. We should also determine the service needs of diabetes nurses and the standards of future careers to reflect the skills and academic achievements of entry and role development.

The limitations of this study are as follows. First, there was significant heterogeneity in all conducted meta-analyses. The cultural and racial differences may be the potential reason for the heterogeneity in 13 trials from 12 countries. Second, compared with other nurse-led RCTs, the sample size of studies we included was small, and the follow-up time of most studies is not sufficient. More high-quality RCTs are needed in the future to help us draw a solid conclusion. Another limitation might be that the follow-up time of the 13 studies ranged from 6 months to 30 months. Finally, Type one diabetes mellitus is recently increasingly appeared in young adults, more studies are needed to examine this population.

CONCLUSION

This review demonstrated that nurse-led interventions can improve HbA1c, BMI, SBP levels in patients with T2DM. Nurse-led diabetes education is an indispensable and important part of disease management, which makes patients and their families fully understand the hazards of the disease and increases the awareness of active participation.

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Contributors The study concept and design were framed by CL and YD. JZ and XZ worked independently, scanned the titles, abstracts and evaluated full text for eligible studies using Note-Express software. CL and YD resolved disagreements by discussion. JZ conducted the statistical data analysis and drafted the manuscript. XZ and DM contributed to discussion and revision. CL and YD contributed to revision. CL and YD are responsible for the overall content as the guarantors. All authors read and approved the final manuscript.

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Competing interests None declared.

Patient and public involvement Patients and/or the public were not involved in the design, or conduct, or reporting, or dissemination plans of this research.

Patient consent for publication Not applicable.

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Provenance and peer review Not commissioned; externally peer reviewed.

Data availability statement All data relevant to the study are included in the article or uploaded as supplementary information. All data from systematic review available in paper and supplementary material.

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