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Impacts of nurse-led clinic and nurse-led prescription on hemoglobin A1c control in type 2 diabetes

A meta-analysis

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Abstract

Background: To evaluate the impacts of nurse-led clinic and nurse-led prescription on hemoglobin A1c (HbA1c) control in type 2 diabetes.

Methods: We searched relevant publications in English and Chinese database and conducted meta-analysis by Stata 12.0. We divided the case groups of included studies into 2 categories according to the role of nurse: nurse-led clinic and nurse-led prescription. Nurse-led clinic was implemented on the basis of standard diabetes care provided by doctor, and control group also receive the standard diabetes care but without nurse-led clinic. The doctor mentioned above might work alone or in a health care team. Nurse-led prescription was prescribed by nurse independently and compared with that of doctor.

Results: The meta-analysis shown that, compared with the standard diabetes care, nurse-led clinic significantly decreases HbA1c level (standard mean difference [SMD] = −0.767; 95% confidence interval [CI]: −1.062, −0.471; $P < .001$). In subgroup analysis, nurse-led clinic also had positive impacts on controlling HbA1c level, no matter in developed countries (SMD = −0.353; 95% CI: −0.6, −0.106; $P = .005$) or developing countries (SMD = −1.114; 95% CI: −1.498, −0.73; $P < .001$). Additionally, there was no significant difference between nurse-led prescription and doctor prescription in controlling HbA1c levels (SMD = −0.203; 95% CI: −0.434, 0.029; $P = .086$).

Conclusion: The nurse-led clinic had positive significance for HbA1c control. Meanwhile, the impact of nurse-led prescription on controlling HbA1c is comparable to that of doctor. It is valuable to provide nurse-led clinic on the basis of standard diabetes care provided by doctor to better control HbA1c, and nurse-led prescription should be provided when doctor-led service is limited.

Abbreviations: HbA1c = hemoglobin A1c, SMD = standard mean difference, T2DM = type 2 diabetes.

Keywords: hemoglobin A1c, meta-analysis, nurse, type 2 diabetes

1. Introduction

Type 2 diabetes (T2DM) is a global epidemic that causes a great burden in human health and economy.[1] The number of T2DM patients has doubled worldwide in the past 20 years. According to the International Diabetes Federation, there were 415 million T2DM patients in 2015, and by 2040, this number will be approximately 642 million.[2] The rapid increase in the incidence of diabetes and limited healthcare resources are great challenges in diabetes management. In the traditional standard diabetes care, the role of nurses is not very crucial. In recent years, some countries have expanded the roles of nurses, including nurse-led clinic and nurse-led prescription.[3,4] Nurses can operate nurse-led clinic on the basis of standard diabetes care provided by doctors or can prescribe medications instead of doctors. The functions of nurse-led clinic include setting behavioral goal, establishing individualized care plan, and providing relevant diabetes knowledge education for patients.[5,6] Nurse-led prescriptions include ordering laboratory tests, prescribing medications, and adjusting medication dosages.[7,8] Many studies have investigated the effects of nurse-led clinic or nurse-led prescription on hemoglobin A1c (HbA1c) control in T2DM.[5,9–11] With inconsistent results being reported, we searched relevant randomized controlled trials (RCTs) and conducted a meta-analysis on these topics.

2. Materials and methods

2.1. Search strategy

Our research was conducted by reviewing previous papers, thus ethical approval is not required. The literature searches were

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operated by 2 reviewers independently in PubMed, Web of Science, Science Direct, Cochrane Central Register of Controlled Trials, and Chinese Databases, including China National Knowledge Infrastructure, China Biology Medicine disc, Chongqing VIP, and Wan Fang Data (updated to March 17, 2019) with the following keywords: "diabetes" and "hemoglobin A1c" and "nurse." Relevant review studies, meta-analysis, and cited references were also estimated for potential studies, any disagreement was reached to agreement after discussion.

2.2. Inclusion and exclusion criteria

Studies included in current meta-analysis met the following inclusion criteria:

(1) RCT;
(2) T2DM patients;
(3) the outcome measure was HbA1c, and provided changes in HbA1c levels or the changes can be calculated;
(4) the control group receive standard diabetes care conducted by doctors, who work alone or work in a health care team;
(5) nurse-led clinic or nurse-led prescription was operated on case group.

The exclusion criteria were as follows:

(1) non-RCT;
(2) the outcome measures without HbA1c;
(3) no sufficient data.

2.3. Data extraction and study quality assessment

Two investigators collected the relevant data independently, and any inconsistency was reached to consistency by discussion. The following information was extracted from each included study: first author; year of publication, country, sample size, follow-up time, components of intervention team, the role of nurse, treatments of case and control groups, and changes in HbA1c level. The Jadad composite scale was applied on assessment of included RCT quality, which assigned scores for reported randomization, blinding, and withdrawals.[12] This is a 5-point scale with a score of at least 3 for high-quality trials and a score of 2 or less for low-quality trials.[13] Any disagreement was resolved by discussion to reach agreement.

2.4. Statistical analysis

We divided the case groups of included studies into 2 categories according to the role of nurse: nurse-led clinic and nurse-led prescription. Nurse-led clinic was implemented on the basis of standard diabetes care provided by doctor, and control group also receive the standard diabetes care but without nurse-led clinic. The doctor mentioned above might work alone or in a health care team. Nurse-led prescription was prescribed by nurse independently and compared with that of doctor. For the changes in HbA1c level, we recorded mean and standard deviation from the studies. Standard mean difference (SMD) with 95% confidence interval (CI) were used to estimate the difference of HbA1c changes between case and control groups. I^2-statistic was applied to calculate heterogeneity among the studies, $I^2 > 50\%$ indicates significant heterogeneity and the random-effects model was used, otherwise the fixed-effects model was applied. We used the funnel plot and the Begg test to detect the publication bias, and $P < .05$ implies statistical significance.[14]

3. Results

3.1. Study characteristics

We initially identified 5021 articles and finally 177 studies for full-text review, from which 17 RCTs with 2701 patients[4,6,9–11,15–24] met the inclusion and exclusion criteria of our meta-analysis. An overview of the methodology of the literature review is presented as PRISMA flow diagram in Figure 1. Among the included RCTs, 8 were Chinese studies, 6 studies were from developed countries, other 3 studies were from the Netherlands and Ireland. There was no statistically significant difference in baseline HbA1C between case and control groups in all studies. The quality of studies was assessed by Jadad score, and 8 RCTs ≥3 scores with high quality, while 9 RCTs less than 3 scores with low quality. The main characteristics and Jadad score of included studies were shown in Table 1.

3.2. Impact of nurse-led clinic on HbA1c control

In 15 RCTs, nurse-led clinic was implemented on the basis of standard diabetes care provided by doctor, and control group also receive the standard diabetes care but without nurse-led clinic. Significant heterogeneity was detected among studies and random-effects model was used ($I^2 = 91.6\%$, $P < .001$). Compared with the standard diabetes care, nurse-led clinic significantly decreases HbA1c level (SMD = −0.767; 95% CI: −1.062, −0.471; $P < .001$) (Fig. 2A). No publication bias was found ($P = .073$) (Fig. 3). When subgroup analysis was operated based on different countries, the nurse-led clinic also had positive impacts on controlling HbA1c level, no matter in developed countries (SMD = −0.353; 95% CI: −0.6, −0.106; $P = .005$) (Fig. 2B) or developing countries (SMD = −1.114; 95% CI: −1.498, −0.73; $P < .001$) (Fig. 2C). Significant heterogeneity was also found in the studies of developed countries ($I^2 = 76.5\%$, $P < .001$) and developing countries ($I^2 = 89.2\%$, $P < .001$).

3.3. Effect of nurse-led prescription on HbA1c control

Nurse-led prescription was prescribed by nurse independently and compared with that of doctor in 2 RCTs. Additionally, there was no significant difference between nurse-led prescription and doctor prescription in controlling HbA1c levels (SMD = −0.203; 95% CI: −0.434, 0.029; $P = .086$; $I^2 = 48.1\%$) (Fig. 2D).

4. Discussion

T2DM, which accounts for more than 90% of diabetes cases, causes microvascular diseases and leads to progressive damage in various organs. T2DM not only results in serious physical and psychological problems to patients but also is a heavy burden to the medical field.[25] Although the risk factors and prevention of T2DM are popularly increasing, its incidence is still increasing.[26] HbA1c results from the glycation of hemoglobin and requires glycemic control in the past 2 to 3 months.[27] HbA1C and glycemic control are very crucial for treating diabetes. Most T2DM patients are outpatients, and many clinic doctors do not have enough time to impart diabetes-related knowledge to patients, especially in developing countries. Furthermore, most patients lack knowledge about diabetes and self-management ability. These inevitably lead to unfavorable HbA1C and glycemic control.[28] The nurse-led clinic, as a novel approach to manage diabetic patients, has been implemented on the basis of

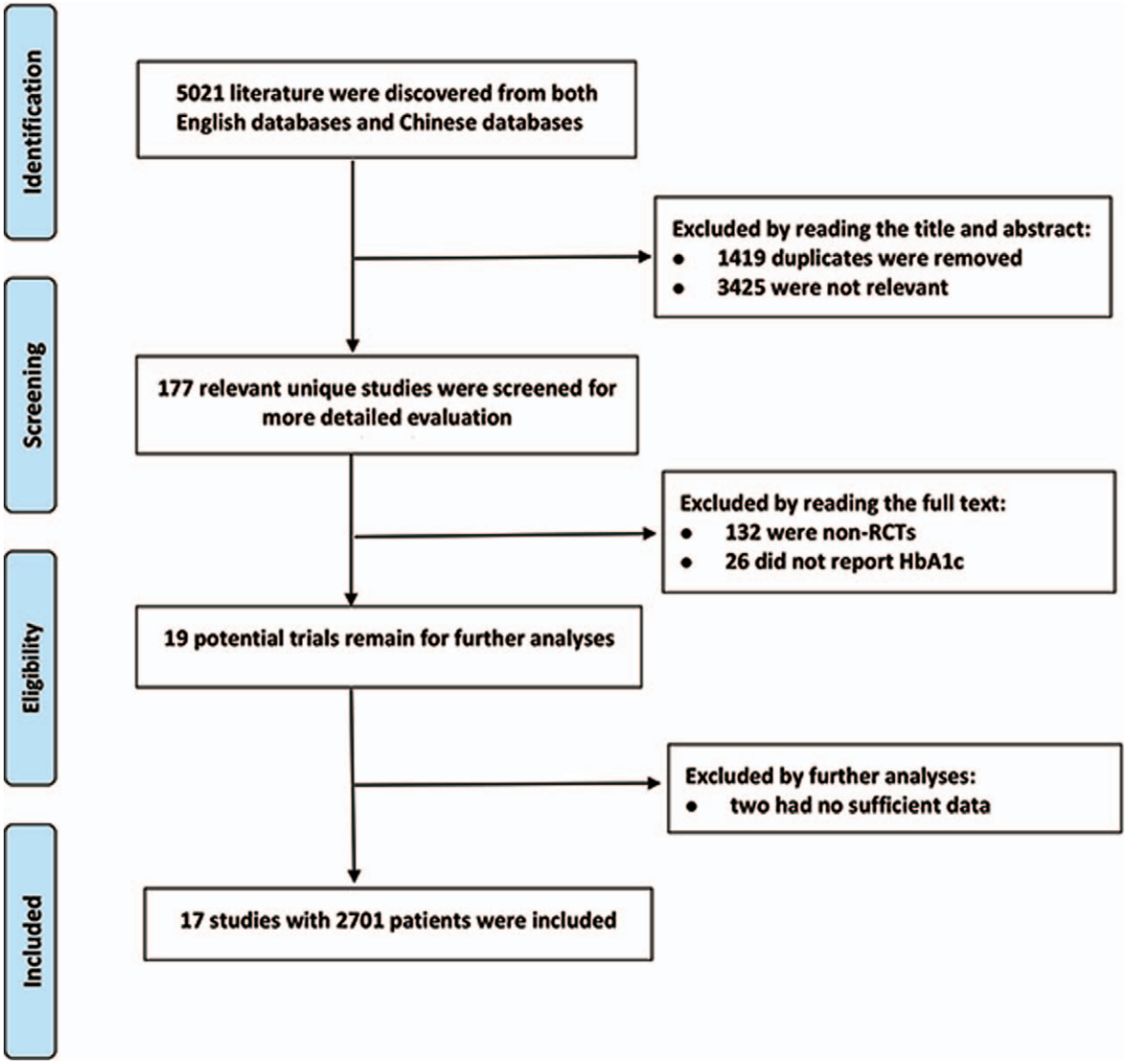

Figure 1. The process of identifying included studies.

standard diabetes care provided by doctors.[15,16] The nurse-led clinic can provide detailed knowledge of diabetes to patients as well as guidance on diet, exercise, glycemic monitoring, and medication to improve HbA1C and glycemic control in T2DM patients. In another case, nurses, instead of doctors, can order laboratory tests, prescribe medications, and adjust the dosages of medications.[7,8]

A relevant English meta-analysis[29] published in 2017 only included 7 RCTs[6–11,16] from developed countries and did not include RCTs from developing countries, and the result showed that nurse-led clinic did not significantly reduce HbA1c level compared with standard diabetes care. In a Chinese meta-analysis[30] published in 2016, 13 RCTs[4,7,8,10,15,17–24] were included with 5[7,8,10,15,17] from developed countries and 8[4,18–24] from developing countries. Although this meta-analysis showed that nurse-led clinic can better control HbA1c level, it combined 2 nurse-led prescription-associated RCTs with nurse-led clinic-associated RCTs to conduct a meta-analysis. This inevitably led to deviations on the conclusions.

Overall, 17 RCTs were included in our current meta-analysis, 9 from developed countries and 8 from developing countries. The included RCTs were divided into the following 2 categories according to the role of nurses: nurse-led clinic and nurse-led prescription. Nurse-led clinic and nurse-led prescription were performed on the case group in 15 RCTs and 2 RCTs, respectively. Our meta-analysis confirmed that compared with standard diabetes care, the nurse-led clinic significantly decreases HbA1c level. The subgroup analysis based on different countries suggested that nurse-led clinic had positive effects on controlling HbA1c level, regardless if it comes from developed countries or developing countries. Although the nurse-led clinic of developing countries is not as progressive as that of developed countries, it is affiliated to the hospitals with abundant medical resources, and relevant nurses are proficient in their clinical work. Furthermore,

Table 1

The main characteristics and Jadad score of included studies.

First author	Year	Country	Case (N)	Control (N)	Follow-up, mo	Intervention team	The role of nurse	Treatment of case group	Treatment of control group	HbA1c changes (mean, SD)				Jadad score
										Case group		Control group		
Aubert RE	1998	America	71	67	12	Nurse case managers Physicians	Nurse-led clinic	Standard diabetes care*	Standard diabetes care	−1.7	1.33	−0.6	1.33	2
Litaker D	2003	America	79	78	12	Nurse practitioners Physicians	Nurse-led clinic	Standard diabetes care Following the blood glucose log and adjusting medication regimens	Standard diabetes care	−0.63	1.5	−0.15	1	4
Taylor CB	2003	America	61	66	12	Nurse case managers Physicians	Nurse-led clinic	Standard diabetes care Assessing treatment adherence Educating on disease self-management strategies Monitoring regularly and delivering feedback	Standard diabetes care Receiving diabetes pamphlets	−1.14	2.34	−0.35	2.43	4
Krein SL	2004	America	106	103	18	Nurse case managers Physicians	Nurse-led clinic	Standard diabetes care Reviewing care and developing self-management in 90 min Holding group sessions in 1 to 2 h weekly for 4 wk Follow up by telephone calls until 52 wk	Standard diabetes care	−0.02	2.02	−0.16	1.89	4
Gabbay RA	2006	America	150	182	12	Nurse case managers Physicians Diabetes nurse educators Dieticians	Nurse-led clinic	Standard diabetes care Scheduling follow-up Encouraging patient self-management on diet and exercise Monitoring home glucose and blood pressure levels	Standard diabetes care	−0.01	1.59	0.04	1.4	3
MacMahon Tone J	2009	Ireland	101	99	12	Nurse specialist in diabetes Physicians	Nurse-led clinic	Standard diabetes care Ordering protocol-driven laboratory tests Providing self-management education and setting behavioral goal Establishing individualized care plan and tracking the outcomes	Standard diabetes care	−0.34	0.97	0.12	0.97	4
Welch G	2011	America	21	18	12	Nurse specialist in diabetes Physicians	Nurse-led clinic	Standard diabetes care Giving advice on diet, exercise, alcohol consumption, and smoking cessation Adjusting medications based on monitoring result and reflecting to patients	Standard diabetes care 1-h diabetes care visits	−1.6	1.4	−0.6	1.1	4
Zhang Y	2011	China	90	91	12	Nurse case managers Physicians	Nurse-led clinic	Standard diabetes care Initiating or increasing diabetes medications by contacting doctors as needed Exploring diabetes self-management behavior to facilitate diabetes education 1-h diabetes care visits conducted by diabetes nurse and dietician	Standard diabetes care	−3.5	0.95	−1.8	1.2	2
Liu C	2013	China	74	74	6	Nurse case managers Physicians	Nurse-led clinic	Standard diabetes care Explanting diabetes knowledge Directing diet, exercise and medications	Standard diabetes care	−2.1	1.41	−1.41	1.54	2

(*continued*)

Table 1

(continued).

First author	Year	Country	Case (N)	Control (N)	Follow-up, mo	Intervention team	The role of nurse	Treatment of case group	Treatment of control group	HbA1c changes (mean, SD)				Jadad score
										Case group		Control group		
								Establishing outpatient files and follow up monthly Adjusting medications based on condition monitoring result						
Zhou L	2013	China	40	40	6	Nurse case managers Physicians	Nurse-led clinic	Standard diabetes care	Standard diabetes care	−3.58	0.97	−1.56	1.08	2
								Explanting diabetes knowledge Directing diet, exercise, medications and psychological problems						
Li W	2013	China	68	66	6	Nurse case managers Physicians	Nurse-led clinic	Standard diabetes care	Standard diabetes care	−3.5	1.4	−1.5	3.8	2
								Explanting diabetes knowledge Directing diet, exercise, medications and psychological problems Follow up the adherence and condition changes of patients						
Wang P	2013	China	120	120	12	Nurse case managers Physicians	Nurse-led clinic	Standard diabetes care	Standard diabetes care	−3.1	1	−1.4	1.1	2
								Giving individual advice on diet based on glycemic level Giving explanation on diabetes and medications knowledge Encouraging patients to do aerobic exercise						
Dong L	2014	China	148	148	3	Nurse case managers Physicians	Nurse-led clinic	Standard diabetes care	Standard diabetes care	−2.02	1.59	−1	1.74	2
								Explanting diabetes knowledge Directing diet, exercise and medications Encouraging patients to communicate with each other.						
Dong G	2015	China	25	25	12	Nurse case managers Physicians	Nurse-led clinic	Standard diabetes care	Standard diabetes care	−1.61	0.77	−0.77	0.77	2
								Explanting diabetes knowledge Directing diet, exercise and medications						
Ding W	2015	China	40	40	12	Nurse case managers Physicians	Nurse-led clinic	Standard diabetes care	Standard diabetes care	−2.84	1.76	−0.97	1.97	2
								Explanting diabetes knowledge Directing diet, exercise, medications and psychological problems						
Houweling ST	2009	Netherlands	46	38	12	Nurse specialist in diabetes	Nurse-led prescription	Nurse prescribe medication based on the guidelines[†] Nurse order laboratory tests	Standard diabetes care Nurse education	−1.5	1.35	−0.9	1.22	3
Houweling ST	2011	Netherlands	102	104	14	Practice nurses	Nurse-led prescription	Nurse prescribe 14 medications and adjusting dosages of 30 medications Nurse were not permitted to prescribe insulin, but were can adjust the dosage Nurse order laboratory tests	Standard diabetes care	−0.09	0.97	0.03	1.39	5

SD = standard deviation.

[*] The standard diabetes care mentioned above were all provided by doctor, who might work alone or in a health care team.

[†] The guidelines are from the Dutch College of General Practitioners and the Dutch Diabetes Federation.

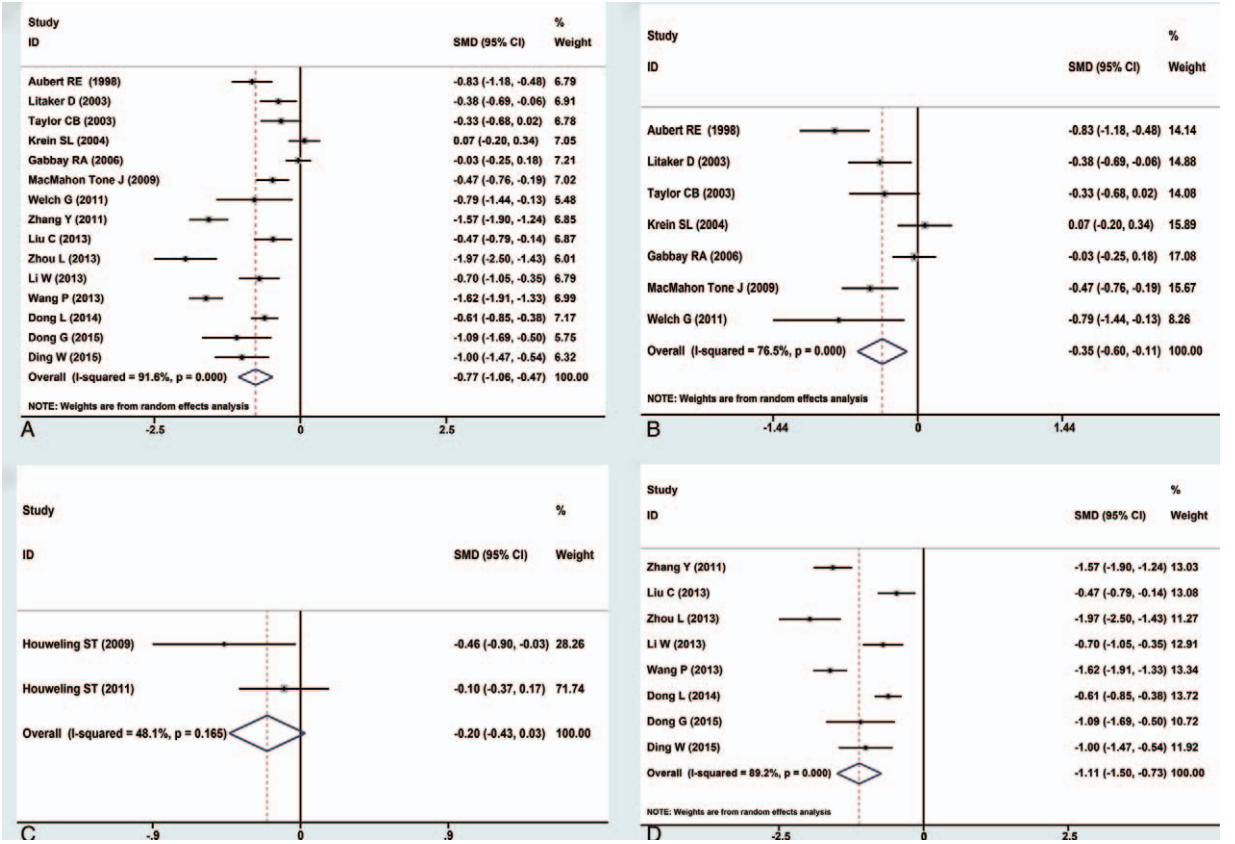

Figure 2. (A) The forest plot of nurse-led clinic and HbA1c level, (B) the forest plot of nurse-led clinic and HbA1c level in developed countries, (C) the forest plot of nurse-led prescription and doctor prescription in controlling HbA1c levels, (D) the forest plot of nurse-led clinic and HbA1c level in developing countries. HbA1c = hemoglobin A1c.

compared with the high expenses and the inconvenient approach of medical treatment in developed countries, the lower cost and convenience of medical treatment in developing countries are more likely to gain the trust and recognition of patients. Therefore, it is possible to enhance the knowledge about diabetes among patients and improve the adherence of patients in developing countries, thus improving HbA1C and glycemic control among T2DM patients. Additionally, our study found that there was no significant difference between nurse-led prescription and doctor-led prescription in controlling HbA1c levels. This result indicated that the HbA1C control provided by nurses was comparable to that provided by doctors. It is valuable to provide nurse-led prescription when doctor-led service is limited.

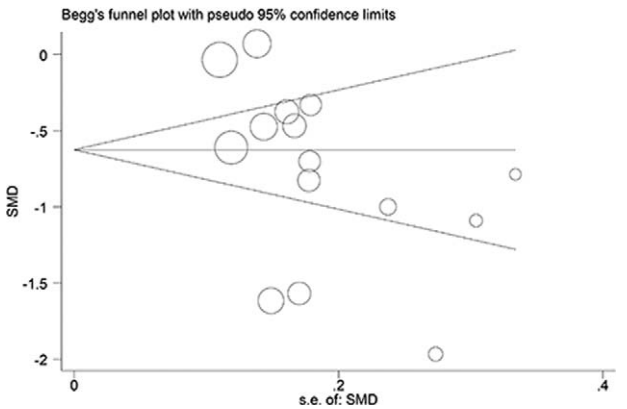

Figure 3. Publication bias for the overall analysis.

Our study evaluated the effect of nurse-led clinic and nurse-led prescription on HbA1c control in T2DM patients, and the results confirmed the positive significance of nurse-led clinic and the feasibility of nurse-led prescription. However, our study had several limitations. First, significant heterogeneity was detected among the included RCTs. Second, only 2 nurse-led prescription-associated RCTs were included in our study; hence, the effect of nurse-led prescription on HbA1c control should be carefully considered. More RCTs should be conducted to verify this result. Additionally, most T2DM patients live in developing countries[31]; however, the quality of included RCTs in developing countries was commonly poor. Therefore, high-quality RCTs in developing countries are needed to confirm the role of nurse-led clinic in controlling HbA1c in T2DM patients.

5. Conclusion

The nurse-led clinic significantly decrease the HbA1c level compared with standard diabetes care, no matter in developed countries or developing countries. Meanwhile, the impact of nurse-led prescription on controlling HbA1c is comparable to that of doctor. It is valuable to provide nurse-led clinic on the

basis of standard diabetes care provided by doctor to better control HbA1c, and nurse-led prescription should be provided when doctor-led service is limited.

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Author contributions

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Methodology: Qun Wang, Yongmin Chen, Xiaohua Li.
Software: Qun Wang, Yan Shen, Yongmin Chen.
Writing – original draft: Qun Wang, Yan Shen, Yongmin Chen.
Writing – review and editing: Xiaohua Li.

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