International Journal of Diabetes in Developing Countries (January–March 2024) 44(1):10–19
https://doi.org/10.1007/s13410-023-01214-3

REVIEW ARTICLE

Diabetes self-care activities among patients with type 2 diabetes: A systematic review and meta-analysis

Omid Khosravizadeh[1] · Bahman Ahadinezhad[1] · Aisa Maleki[2,3] · Sama Yousefy[3] · Zeinab Momeni[3]

Received: 10 May 2022 / Accepted: 21 May 2023 / Published online: 16 June 2023

Abstract

Objectives The important role of prevention in controlling chronic diseases such as diabetes, the major impact of self-care behaviors as preventive behaviors, and the lower cost of self-care measures should be considered. Therefore, this study was conducted to systematically review and meta-analyze the status of diabetes self-care activities status in type 2 diabetic patients worldwide.

Methods As far as we know, our study is the first systematic based meta-analysis estimating the pooled score of diabetes self-care activities (SDSCA) and its dimensions among type 2 diabetic patients. Keywords were searched in Scopus, Web of Science, Google Scholar, PubMed, Cochrane, Ovid, and ProQuest databases from 2012 to 2022. The self-care pooled score estimates through a fixed-effects meta-analysis using STATA 15. Also, I^2 statistic was used to determine heterogeneity across the articles.

Results Seventeen studies on the diabetes self-care activities were included in the meta-analysis. Variation in pooled mean attributable to heterogeneity for exercise and self-care is zero, while the variation for foot cares, general diet, and blood testing were estimated to be 53, 20.6, and 81.4%, respectively ($p < 0.01$). The random effects based pooled mean was estimated as follows: foot care (FC) 2.02 (95% CI: 1.05, 2.98), general diet (GD) 3.91 (95% CI: 3.21, 4.60), and blood testing (BT) 1.82 (95% CI: 0.64, 3.01). As well as based on the fixed effects, the pooled mean of exercise (E) and the total score of self-care (TSC) were obtained 2.12 (95% CI: 1.77, 2.47) and 3.35 (95% CI: 2.96, 3.74), respectively.

Conclusion The overall level of self-care was moderate and far from ideal. Dimensions of foot care, exercise, and blood glucose testing were also below average. Based on this evidence, policies to prevent diabetes should be directed toward educating patients on preventive activities. On the other hand, it is necessary to ensure that patients' interpretations are in line with doctors' recommendations.

Keywords Diabetes self-care activities · SDSCA · Type 2 diabetes · Systematic review · Meta-analysis

Introduction

Diabetes is on the list of the most common chronic diseases nowadays [1]. Type 2 diabetes is the most common type and usually involves adults. Type 2 diabetes is a condition in which the body does not produce enough insulin or becomes insulin resistant. About 422 million people worldwide suffer from diabetes, most of whom live in low- and middle-income countries. Diabetes is the cause of 1.5 million deaths annually. All countries of the world, regardless of income level, have witnessed a significant increase in the prevalence of type 2 diabetes over the past 30 years

✉ Aisa Maleki
AisaMalekii@gmail.com

Omid Khosravizadeh
Omid.khosravizadeh@gmail.com

Bahman Ahadinezhad
bahmanahadi2009@gmail.com

Sama Yousefy
Sama.yousefy2379@gmail.com

Zeinab Momeni
zeinabmomeni2001@gmail.com

[1] Social Determinants of Health Research Center, Research Institute for Prevention of Non-Communicable Diseases, Qazvin University of Medical Sciences, Qazvin, Iran

[2] Health Products Safety Research Center, Qazvin University of Medical Sciences, Qazvin, Iran

[3] Student Research Committee, Qazvin University of Medical Sciences, Qazvin, Iran

[2]. The global prevalence of diabetes is estimated to grow by about 2% by 2045. Diabetes prevalence is also expected to be greater in urban areas and middle- and upper-income countries. Global diabetes health spending was about $966 billion in 2021 and it is expected to reach $1054 billion by 2045 [2]. At the same time, what causes irreversible complications is that one in two patients suffering from diabetes is unaware of the disease [1]. Diabetes is a critical health issue because its complications directly affect the quality of life and can lead to death [3]. Stroke, cardiovascular disease, and peripheral artery disease (PAD) are the macrovascular complications of diabetes [1]. Studies have shown that the patient's knowledge about the disease and its health-related behaviors is the most important factor in controlling it [4]. A person's beliefs and knowledge about illness determine his or her health-related behaviors and self-care activities [5]. The concept of belief and knowledge can improve the health and safety of the patient and thus reduce the costs of treatment and care [6]. Therefore, one of the most widely used concepts in this field is diabetes self-care activities. A reliable tool entitled "diabetes self-care activities" has been used in studies around the world that include the dimensions of foot care, diet, exercise, and blood glucose testing [7]. The important role of prevention in controlling chronic diseases such as diabetes, the major impact of self-care behaviors as preventive behaviors, and the lower cost of self-care measures should be considered. Therefore, this study was conducted to systematically review and meta-analyze the status of diabetes self-care activities status in type 2 diabetic patients worldwide.

Materials and methods

Study design

This systematic meta-analytical review studies diabetes self-care activities in countries around the world. The search was conducted for 10 years (from 2012 to February 2022). A PRISMA-based (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) literature review was performed [8].

Search strategy

The main domains of the search included type 2 diabetes, self-care activities, and foot care. Keywords were also obtained from Medical Subject Heading (MeSh), literature review, and statements of experts in the field. It was then concluded with a pilot search. Keywords were "diabetic foot," "diabetic feet," "diabetes self-care activities," "SDSCA," "self-care," "self-care behavior," "attitude to health," "health behavior," "foot care," and "care behavior." AND, OR, and NOT Booleans used to bound the search. The search strategy was developed by two experts in the field of health services management who are well-experienced in patients' health behavior (OKh and AMa) and a specialist in systematic review and meta-analysis (BAh). The sample search strategy is shown below.

TITLE-ABS-KEY ("diabetic foot" OR "diabetic feet") AND TITLE-ABS-KEY ("diabetes self-care activities" OR "SDSCA" OR "self-care" OR "self-care behavior" OR "attitude to health" OR "health behavior" OR "foot care" OR "care behavior") AND (LIMIT-TO (PUBYEAR, 2021) OR LIMIT-TO (PUBYEAR, 2020) OR LIMIT-TO (PUBYEAR, 2019) OR LIMIT-TO (PUBYEAR, 2018) OR LIMIT-TO (PUBYEAR, 2017) OR LIMIT-TO (PUBYEAR, 2016) OR LIMIT-TO (PUBYEAR, 2015) OR LIMIT-TO (PUBYEAR, 2014) OR LIMIT-TO (PUBYEAR, 2013) OR LIMIT-TO (PUBYEAR, 2012)) AND (LIMIT-TO (DOCTYPE, "ar")) AND (LIMIT-TO (LANGUAGE, "English")).

Databases

Keywords were searched in Scopus, Web of Science, Google Scholar, PubMed, Cochrane, Ovid, and ProQuest databases. Springer and SAGE journals and some other key journals in the field were also searched manually. To enhance search scope, pre-prints, references, citation lists, and relevant papers were also examined.

Inclusion criteria

(1) Articles that had type 2 diabetic patient samples
(2) Articles that examined the dimensions of foot care, general diet, exercise, and blood testing of diabetes self-care activities
(3) Articles in which the mean and standard deviation of diabetes self-care activities (SDSCA) and its dimensions were reported or calculable
(4) Articles in which the patients studied had diabetic foot ulcers
(5) Peer-reviews, time-series, and cross-sectional studies

Exclusion criteria

(1) Articles related to type 1 diabetes and gestational diabetes

(2) Non-English articles
(3) Articles considering other questionnaires
(4) Articles out of sufficient information to enter the meta-analysis
(5) Secondary documents such as editorials and conference abstracts
(6) Mathematical modeling articles
(7) Meta-analyses and reviews

Review process

First, papers were compiled in EndNote X8. Next, duplicates and disjointed titles were skipped. The three researchers (AMa, SYo, ZMo) individually evaluated the titles and abstracts in terms of adherence with the inclusion and exclusion criteria. A list of the remaining papers was prepared to review the full texts. Two (AMa and SYo) researchers individually read the full texts of the remaining papers and adjusted them to the research question. If there was controversy in the above cases, two other researchers (OKh and BAh) would also examine the argument. Ultimately, two researchers extracted data from the papers into the data assemblage table. The table retains the author's name, year of publication, country, mean, and standard deviation. This table has been adjusted based on pilot testing on five articles.

Quality assessment and critical appraisal

By finishing the searching process, the included papers were assessed by three researchers (AMa, SYo, and ZMo) using the Newcastle–Ottawa Scale. It is a tool applied for the quality assessment of non-randomized studies included in a meta-analysis or systematic review. This tool retains three classifications and 8 items. Classifications include study group selection, group comparability, and determination of intervention or outcome for case–control or cohort studies, respectively. Qualitative evaluation is done by rewarding stars to each item [9]. Papers acquire between 0 and 10 points. Ultimately, articles that acquired a score below the average score were omitted. The remaining papers were selected and data including author name, year of publication, country, sample size, and mean and standard deviation of each dimension were documented in a data extraction template based on the PRISMA guidelines for systematic reviews.

Data analysis

Diabetes self-care activities (SDSCA) and its dimensions pooled score (PS) were approximated by random-effects meta-analysis, using STATA 15. The analysis results were demonstrated at a 95% confidence interval. I^2 statistics were used to investigate the possibility of heterogeneity across the publications ($I^2 \geq 50\%$ indicates heterogeneity). A forest plot was applied to show the results. An Egger test was executed to assess the publication bias.

Results

A total of 2061 papers were obtained from the search, of which 563 were duplicates. After removing duplicates, the title and abstract of 945 papers were matched with inclusion and exclusion criteria and inconsistencies were removed. Five hundred thirty-six full texts were rejected due to lack of quality after evaluation. Finally, 17 articles on diabetes self-care activities were meta-analyzed (Fig. 1). The characteristics of the articles included in the study are reported in Table 1.

Table 2 shows the degree of heterogeneity between studies based on the studied variable. The results of this table reveal that variation in pooled mean attributable to heterogeneity for exercise and self-care is zero, while the variation for foot cares, general diet, and blood testing were estimated to be 53, 20.6, and 81.4%, respectively ($p < 0.01$). However, general diet heterogeneity was not statistically significant.

The pooled mean (PM) and the 95% confidence interval for each of the study variables based on the estimation model are presented in Table 2. The pooled mean for foot care, general diet, and blood testing are different in the two models. There has been variation attributable to heterogeneity for these variables. Therefore, the random effects based pooled mean is acceptable to us. According to the results of Table 3 and Figs. 2 and 3, the pooled mean for these variables was estimated as follows: foot care (FC) 2.02 (95% CI: 1.05, 2.98), general diet (GD) 3.91 (95% CI: 3.21, 4.60), and blood testing (BT) 1.82 (95% CI: 0.64, 3.01). As well as based on the fixed effects, the pooled mean of exercise (E) and the total score of self-care (TSC) were obtained 2.12 (95% CI: 1.77, 2.47) and 3.35 (95% CI: 2.96, 3.74), respectively.

As the information in Table 4 displays, the bias coefficient is statistically significant only for the total self-care score and general diet ($p < 0.05$). Other dimensions of self-care (foot care, exercise, and blood testing) did not suffer from publication bias.

The funnel plots in Fig. 4 illustrate the result of the assessment of the publication bias for the self-care visually. The results of these graphs also confirm the existence of a publication bias for self-care at the 95% level.

Figure 5 illustrates the forest plot of the sensitivity analysis of the pooled mean of the self-care score. As it is known,

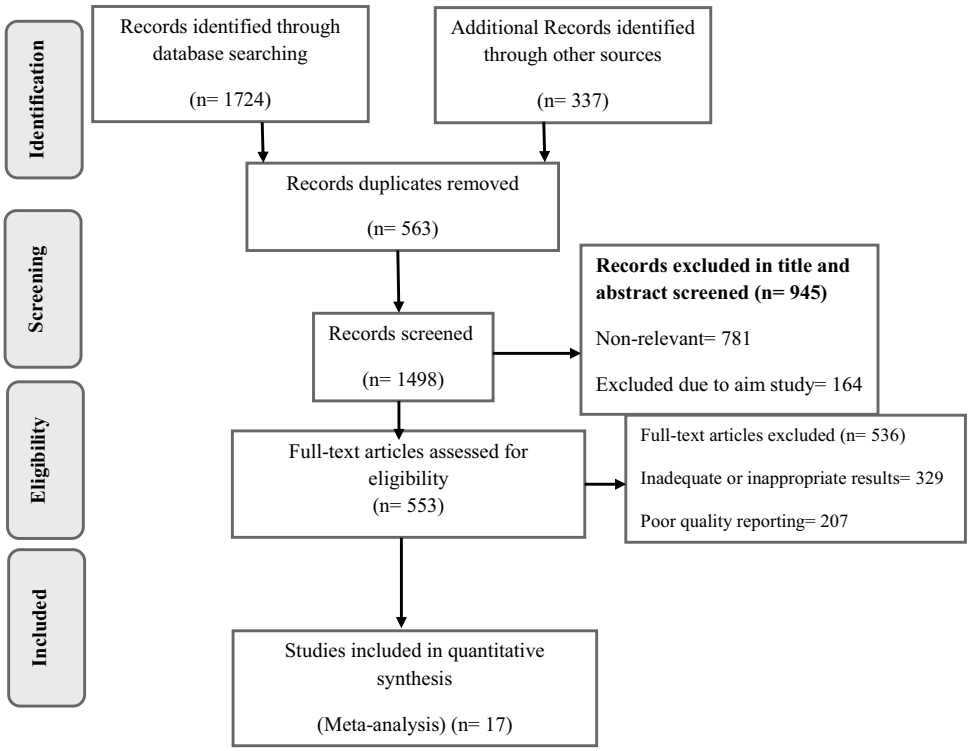


Fig. 1 The flow diagram of the literature search

the aggregated average is not sensitive to the results of individual studies. That is, removing the results of individual studies has no effect on the significance of the pooled mean score of self-care.

Discussion

This study measured the global pooled mean of diabetes self-care activities and its dimensions including foot care, diet, exercise, and blood glucose testing. The pooled mean of self-care activities in type 2 diabetic patients was moderate (3.36). Among the self-care activities, adherence to the diet, although slightly above average (4.84), was the strongest dimension. Blood glucose testing (2.40), foot care (2.37), and exercise (2.13) were below average, and with a small difference, exercise was the weakest dimension.

Regarding to diet dimension, Malaysia has the highest (5.20) and Korea the lowest (0.92) mean. This dimension includes the number and type of meals received during the day. The relatively higher average of this dimension can be due to more education about diet and the existence of nutritional guides on food labels. Rajput et al. demonstrated the critical role of diet in controlling type 2 diabetes in their review [27]. A study by Degefa et al. in the line with present study showed that the total mean of diet adherence is moderate and even low in African countries. Many factors influence the way in which diet-related behaviors occur [28]. These factors include beliefs, lifestyle, affordability, family support, access to healthy food, fruits, and vegetables, enough nutrition knowledge, and a correct understanding of medical advice [28, 29]. Many studies showed that lack of access to healthy food due to seasonal or economic barriers, as well as lack of knowledge in the field of healthy nutrition, also undermines the diabetic diet [11, 30, 31].

Regarding the blood sugar testing dimension, Italy has the highest (4.32) and Korea the lowest (0.14) mean. This dimension includes the number of blood sugar tests. In confirmation of the present study, a systematic review by Stephani et al. showed that this dimension has a low level, especially in poor countries [32]. On the other hand, these tests are more common in people who have access to a home glucometer [32–35]. Patients who inject insulin are more knowledgeable and skilled in performing constant blood sugar testing [29]. Many factors play a role in determining this dimension, including financial affordability, attitude toward testing, knowledge about the importance of testing, testing skills, social support, doctor's advice, and insurance coverage.

Regarding to foot care dimension, Iran has the highest (4.56) and Lebanon the lowest (0.33) mean. This dimension

Table 1 Characteristics of the descriptive cross sectional studies included in the meta-analysis

Ref	Author	Setting	Place	Year	Sample	Foot care		General diet		Exercise		Blood testing		SDSCA	
						Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
[10]	I.L. Jackson, et al	Nigeria	The University of Uyo Teaching Hospital, Akwa Ibom State	2021	226	2.5	2.1	3.95	1.15	2.4	1.2	1	1.1	2.76	1.34
[11]	Victor Mogre, et al	Ghana	Three hospitals in the Tamale Metropolis	2019	187	2.86	2.16	4.4	1.52	4.78	2.09	2.15	0.65	3.54	1.8
[12]	Ola Sukkarieh, et al	Lebanon	Lebanese American University, Byblos	2016	140	1.19	2.11	3.63	2.37	1.37	2.1	2.5	2.48	2.46	2.28
[13]	Ali Hassan Alhaiti, et al	Saudi Arabia	King Fahad Medical City (KFMC)	2020	247	3.28	1.69	2.57	1.74	2.14	2.01	4.18	2.43	3.04	1.96
[14]	Najwa S. ElGerges, et al	Lebanon	The primary healthcare center (PHC) diabetes clinic	2020	50	0.33	0.51	3.03	1.66	1.79	2.01	0.53	1.07	2.48	0.77
[15]	Sana Taher Ashur, et al	Libya	The National Centre for Diabetes and Endocrinology (NCDE) in Tripoli	2016	523	2.3	2.6	2.9	2.6	2.5	2.3	1.2	1.9	2.22	2.35
[16]	Sofia Akritidou, et al	Greece	Aretaeus Diabetes Center	2017	22	1.57	1.31	3.43	1.29	1.82	1.68	4	1.78	2.705	1.515
[17]	Hamdiye Arda Sürücü, et al	Turkey	The university hospital or the training and research hospital in the southeast of Turkey	2017	220	0.96	0.82	1.72	1.05	0.88	0.79	1.12	0.79	1.17	0.86
[18]	Marilia Braga Marques, et al	Brazil	Primary Health Care Units of Fortaleza/Ceará	2019	50	4.5	3.11	3.81	2.35	1.82	2.47	1.38	2.32	2.8775	2.5625
[19]	Kathleen Mulligan, et al	UK	UK National Health Service organizations and mental health and diabetes charities	2018	77	1.7	1.8	3.85	2.05	2.4	2.1	3.8	2.7	3.12	2.14
[20]	Azar Tol, et al	Iran	Omolbanin center, an outpatient diabetic center in Isfahan	2012	140	4.56	2.14	3.7	1.31	2.11	1.89	2.12	2.12	3.23	1.75
[21]	Anfal N. Al-Mallah, et al	Iraq	The Leila Qasm Diabetic Centre, Erbil	2017	50	4.2	2.8	3.15	1.55	2.6	2	1.6	2.1	2.8875	2.1125
[22]	Yee Cheng Kueh, et al	Malaysia	The Diabetes Clinic of the Hospital University Sains Malaysia (HUSM) in Kelantan	2016	266	3	2.65	5.2	2.15	2.5	2.34	1.2	1.81	2.97	2.23
[23]	Renu Bala, et al	India	The outpatient department (OPD) of Regional Research Institute for Homoeopathy, Imphal	2020	108	0.39	1.42	3.86	1.39	3.95	2.29	0.14	0.39	2.085	3.06
[24]	Young Mi Kang, et al	Korea	Chungnam National University Hospital	2018	23	1.14	3.31	0.92	3.48	0.59	1.05	0.33	2.4	0.745	2.56
[25]	Kyung Suk Shin, et al	Korea	Three community health centers in South Korea	2017	71	1.98	2.4	3.42	2.26	4.45	2.24	0.88	1.81	2.6825	2.1775
[26]	Davide Ausili, et al	Italy	Hospital ASST Sette Laghi, Varese	2017	302	3.32	0.3	4.97	0.12	2.2	0.2	4.32	0.3	3.7025	0.23

Measuring tool: the summary of diabetes self-care activities (SDSCA)

Studies' population: patients suffering diabetes type 2

Table 2 Heterogeneity and significance statistics of pooled mean

Statistics	Variables				
	FC	GD	E	BT	TSC
Heterogeneity I^2 (%)	53.3	20.6	0.0	81.4	0.0
Heterogeneity χ^2 (d.f. = 16)	34.26 $p < 0.01$	20.15 $p = 0.214$	8.47 $p = 0.934$	86.25 $p < 0.01$	12.25 $p = 0.726$
PM = 0	$z = 10.55$ $p < 0.01$	$z = 42.05$ $p < 0.01$	$z = 11.87$ $p < 0.01$	$z = 12.22$ $p < 0.01$	$z = 16.94$ $p < 0.01$

FC foot care, *GD* general diet, *E* exercise, *BT* blood testing, *TSC* total self-care, *PM* pooled mean

refers to the frequency of foot care and shoe inspection. In line with this meta-analysis, foot care activities are weak in many studies [28, 29, 36–39]. At the same time, patients who suffer from foot ulcers are more likely to seek foot care than patients who do not yet have foot ulcers. According to a study by Alosaimi et al., these activities were twice as common in patients with foot ulcers as in patients without foot ulcers [40]. A study by Stephani et al. showed that foot care is more common in women than men [32]. Reasons for not doing enough foot care activities can be lack of adequate training and medical advice, negative attitude toward these activities, lifestyle and how people use their feet, lack of time to take care of feet, too much work, lack of communication with the doctor, lack of support, and time-consuming and abnormal care activities.

Regarding to exercise dimension, Ghana has the highest (4.78) and Korea the lowest (0.59) mean. This dimension refers to the number and duration of physical activity. According to the present study, physical activity has a small share in diabetes self-care behaviors [28, 41–44]. Lack of physical activity may be due to lifestyle, lack of time, lack of adequate training and advice, physical condition, and cultural differences. Thus, the lack of access to exercise facilities and the lack of motivation lead to reducing this behavior, and explaining the importance and promotion of knowledge in this field strengthens this dimension [28].

Financial barriers, deficit knowledge and awareness of self-care, lack of specific protocols to guide diabetic patients in the field of self-care, difficulty interacting between patient and service provider, deficit knowledge of healthy lifestyle, hardship abandoning bad habits, lack of confidence, lack of patient self-esteem and self-efficacy, unilateral training, patients' lack of time, patients' job barriers, patients' disappointment, and lack of motivation are obstacles that undermine self-care. Social norms, people's attitudes toward diabetes, social stigma, lack of community or family and peer support, family conflicts, cultural beliefs, self-treatment and use of herbal remedies, believing that diabetes is caused by negative spiritual forces, and deliberate non-compliance are other decisive factors that weaken the various dimensions of self-care [11, 30, 31, 45–48].

The low pooled mean of diabetes self-care activities and its dimensions indicate that there is a lack of knowledge and education in this field. Given that the best way to cope with diabetic foot ulcers is to prevent them, it is necessary to strengthen all dimensions of self-care. Adherence to diet, physical activity, and frequent blood sugar tests are all necessary to prevent diabetic foot ulcers. Simultaneously, direct foot care activities are important, especially for people who suffer from foot ulcers.

Some measures that can be taken to enhance self-care include (1) improvement of patient interaction and service providers, (2) encourage family and community to support patients with diabetes, (3) improvement and facilitate the process of service delivery, (4) facilitating access to healthy food, (5) creating environments compatible with patients with diabetes, (6) motivating patients and their family, (7) modification of the attitudes, norms, and values of the society toward diabetes, and (8) use of technologies (such as cell phones) for education, reminder, the

Table 3 Pooled mean of variables based on fixed and random effects model

Model	Variables									
	FC		GD		E		BT		TSC	
	PM	95% CI	PM	95% CI	PM	95% CI	PM	95% CI	PM	95% CI
Fixed effect	2.37	1.93, 2.81	4.83	4.61, 5.06	2.12	1.77, 2.47	2.40	2.02, 2.79	3.35	2.96, 3.74
Random effect	2.02	1.05, 2.98	3.91	3.21, 4.60	2.12	1.77, 2.47	1.82	0.64, 3.01	3.35	2.96, 3.74

FC foot care, *GD* general diet, *E* exercise, *BT* blood testing, *TSC* total self-care, *PM* pooled mean, *CI* confidence interval

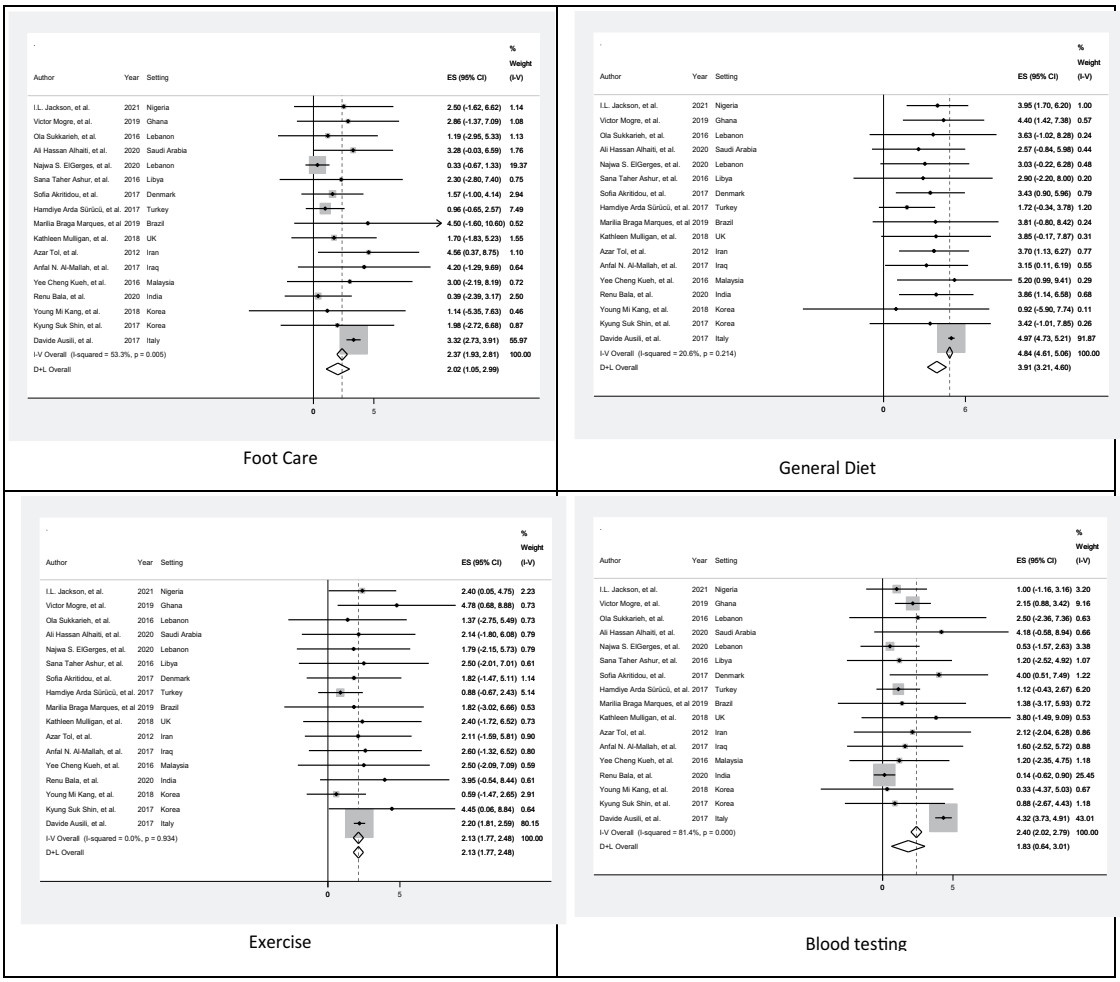


Fig. 2 Forrest plot for self-care dimensions

Fig. 3 Forrest plot for total self-care

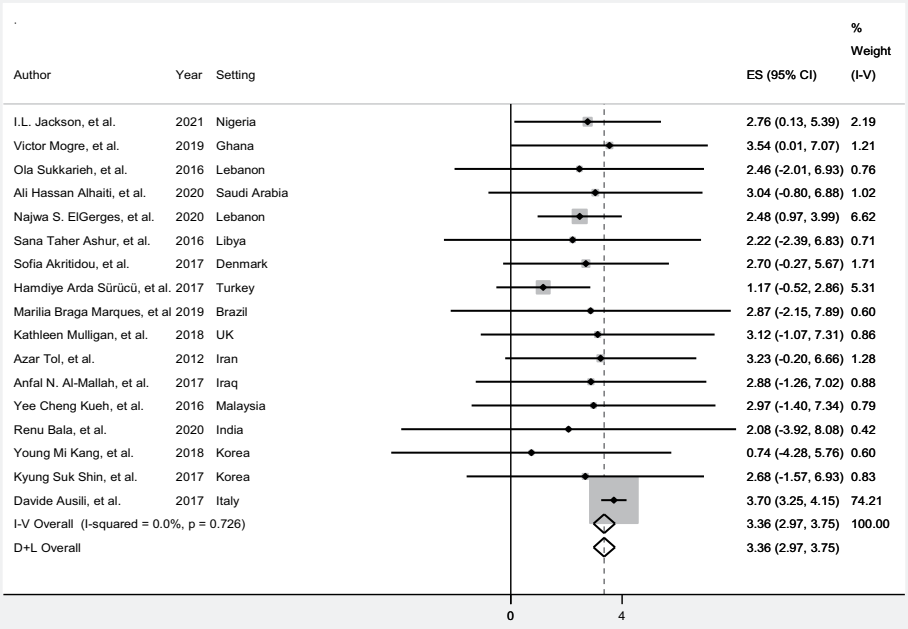


Table 4 Egger's test for assessing the publication bias

Variables	Bias Coef	SE	*t*	$p > \|t\|$	95% CI
FC	−0.315	0.519	−0.61	0.552	−1.422, 0.791
GD	−1.006	0.195	−5.12	0.001	−1.417, −0.584
E	0.051	0.231	0.22	0.831	−0.443, 0.544
BT	−0.839	0.852	−0.98	0.340	−2.655, 0.977
TSC	−0.675	0.232	−2.91	0.011	−1.171, −0.181

FC foot care, *GD* general diet, *E* exercise, *BT* blood testing, *TSC* total self-care

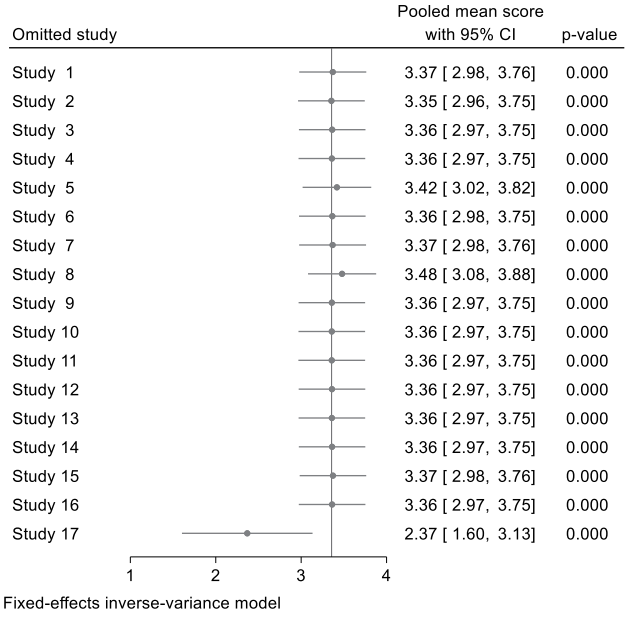


Fig. 5 Leave one out meta-analysis of diabetic foot self-care score mean

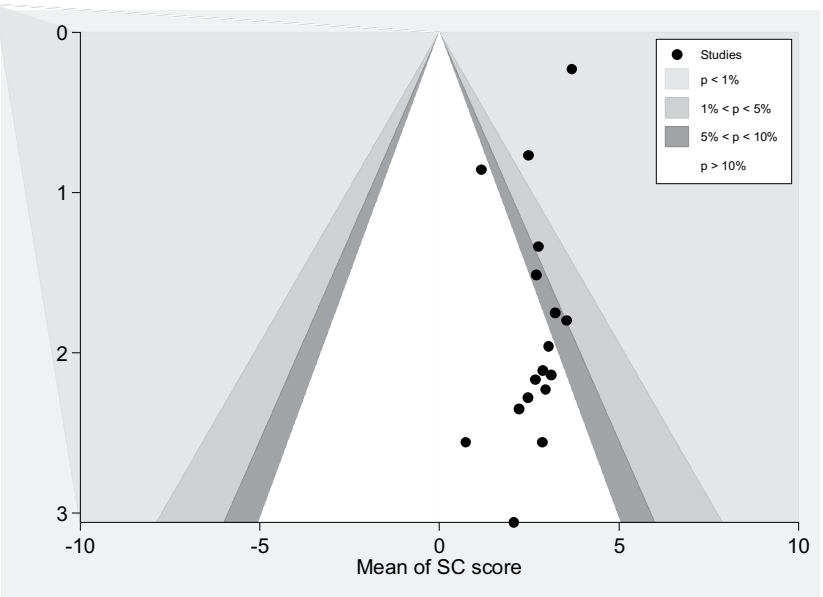
interaction of patients and service providers and changing patients' bad behaviors [30, 45–47].

This study also has some limitations. The first constraint is that in order to decrease the amount of heterogeneity, we only pooled the SDSCA and its dimensions' scores and excluded studies that used other methods such as semantic priming task, evaluative priming task, affect misattribution procedure, and extrinsic affective Simon task. The second constraint is that only English articles were contained in the analysis. It should be mentioned, however, that we endeavored to overwhelm this constraint by systematically reviewing the most popular databases.

Conclusion

This study obtained the pooled mean of diabetes self-care activities including diet, foot care, exercise, and blood glucose testing in different countries for the first time. The overall level of self-care was moderate and far from ideal. Dimensions of foot care, exercise, and blood glucose testing were also below average. Based on this evidence, policies to prevent diabetes should be directed toward educating patients on preventive activities. On the other hand, it is necessary to ensure that patients' interpretations are in line with doctors' recommendations. The capacity of skilled nurses can be used for self-care training and follow-up so that the shortage of physicians does not prevent continuous monitoring of self-care activities.

Fig. 4 Funnel plot for self-care



Data availability Not applicable.

Declarations

Ethics consideration The present study has ethical approval from the ethics committee of Qazvin University of Medical Sciences (ethics code IR.QUMS.REC.1401.329).

Competing interests The authors declare no competing interests.

References

1. Khan RMM, Chua ZJY, Tan JC, Yang Y, Liao Z, Zhao Y. From pre-diabetes to diabetes: diagnosis, treatments and translational research. Medicina. 2019;55(9):546.
2. Organization wh. Diabetes. Fact sheets https://www.who.int/news-room/fact-sheets/detail/diabetes. 2021. Accessed 7 Jun 2023.
3. Caruso P, Longo M, Gicchino M, Scappaticcio L, Caputo M, Maiorino MI, et al. Long-term diabetic complications as predictors of foot ulcers healing failure: a retrospective study in a tertiary-care center. Diabetes Res Clin Pract. 2020;163: 108147.
4. Yuen L, Saeedi P, Riaz M, Karuranga S, Divakar H, Levitt N, et al. Projections of the prevalence of hyperglycaemia in pregnancy in 2019 and beyond: results from the International Diabetes Federation Diabetes Atlas. Diabetes Res Clin Pract. 2019;157: 107841.
5. Khosravizadeh O, Ahadinezhad B, Maleki A, Vosoughi P, Najafpour Z. Applying the health belief model and behavior of diabetic patients: a systematic review and meta-analysis. Clin Diabetol. 2021;10(2):200–11.
6. Khosravizadeh O, Mohseni M, Baghian N, Maleki A, Hashtroodi A, Yari S. Front-line staff's perspective on patient safety culture in Iranian medical centers: a systematic review and meta-analysis. Int J Risk Saf Med. 2020;31(4):193–207.
7. Alghadeer SM, Alsuwayni B, Almuwayjid AK, Almadi MS, Mubarak AM, Khunayn RMb, et al. Glycemic control and management in pharmacist-led diabetic clinic vs. physician-led diabetic clinic. Medicina. 2022;58(1):14.
8. Liberati A, Altman DG, Tetzlaff J, Mulrow C, Gøtzsche PC, Ioannidis JP, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: explanation and elaboration. J Clin Epidemiol. 2009;62(10):e1–34.
9. Lo CK-L, Mertz D, Loeb M. Newcastle-Ottawa Scale: comparing reviewers' to authors' assessments. BMC Med Res Methodol. 2014;14(1):1–5.
10. Jackson IL, Onung SI, Oiwoh EP. Self-care activities, glycaemic control and health-related quality of life of patients with type 2 diabetes in a tertiary hospital in Nigeria. Diabetes Metab Syndr. 2021;15(1):137–43.
11. Mogre V, Abanga ZO, Tzelepis F, Johnson NA, Paul C. Psychometric evaluation of the summary of diabetes self-care activities measure in Ghanaian adults living with type 2 diabetes. Diabetes Res Clin Pract. 2019;149:98–106.
12. Sukkarieh-Haraty O, Howard E. Psychometric properties of the Arabic version of the summary of diabetes self-care activities instrument. Res Theory Nurs Pract. 2016;30(1):60–9.
13. Alhaiti AH, Senitan M, Dator WLT, Sankarapandian C, Baghdadi NA, Jones LK, et al. Adherence of type 2 diabetic patients to self-care activity: tertiary care setting in Saudi Arabia. J Diabetes Res. 2020;2020:4817637.
14. ElGerges NS. Effects of therapeutic education on self-efficacy, self-care activities and glycemic control of type 2 diabetic patients in a primary healthcare center in Lebanon. J Diabetes Metab Disord. 2020;19(2):813–21.
15. Ashur ST, Shah SA, Bosseri S, Fah TS, Shamsuddin K. Glycaemic control status among type 2 diabetic patients and the role of their diabetes coping behaviours: a clinic-based study in Tripoli, Libya. Libyan J Med. 2016;11:31086.
16. Akritidou S, Husted GR, Kazakos K, Olesen K. The effect of using interactive communication tools in adults with type-2 diabetes. Nursing Reports. 2017;7(1):1–3.
17. ArdaSürücü H, BüyükkayaBesen D, Erbil EY. Empowerment and social support as predictors of self-care behaviors and glycemic control in individuals with type 2 diabetes. Clin Nurs Res. 2018;27(4):395–413.
18. Marques MB, Coutinho JFV, Martins MC, Lopes MVdO, Maia JC, Silva MJd. Educational intervention to promote self-care in older adults with diabetes mellitus. Revista da Escola de Enfermagem da USP. 2019;53:e03517.
19. Mulligan K, McBain H, Lamontagne-Godwin F, Chapman J, Flood C, Haddad M, et al. Barriers to effective diabetes management–a survey of people with severe mental illness. BMC Psychiatry. 2018;18(1):1–15.
20. Tol A, Shojaeezadeh D, Eslami A, Alhani F, Mohajeritehrani M, Baghbanian A, et al. Evaluation of self-care practices and relative components among type 2 diabetic patients. J Educ Health Promot. 2012;1:19.
21. Al-Mallah AN, Tawfiq NO, Dizaye K. The role of a clinical pharmacist in lifestyle modification in type 2 diabetic patients with peripheral neuropathy in Erbil, Iraq. JPMC. 2017;3(2):57.
22. Kueh YC, Morris T, Ismail A-A-S. The effect of diabetes knowledge and attitudes on self-management and quality of life among people with type 2 diabetes. Psychol Health Med. 2017;22(2):138–44.
23. Bala R, Srivastava A, Potsangbam T, Anal L, Ningthoujam GD. Self care practices and psychological distress among diabetic patients in Manipur during COVID-19: a scenario from the north east. Diabetes Metab Syndr. 2021;15(1):93–8.
24. Kang YM, Kim HJ, Lee T-Y, Ku B-J. Effect of glucose control, SDSCA and quality of life of D-chiro-inositol (DCI) in patients with type 2 diabetes: a path analysis. Journal of the Korea Academia-Industrial cooperation Society. 2018;19(10):243–53.
25. Shin KS, Lee EH. Relationships of health literacy to self-care behaviors in people with diabetes aged 60 and above: empowerment as a mediator. J Adv Nurs. 2018;74(10):2363–72.
26. Ausili D, Bulgheroni M, Ballatore P, Specchia C, Ajdini A, Bezze S, et al. Self-care, quality of life and clinical outcomes of type 2 diabetes patients: an observational cross-sectional study. Acta Diabetol. 2017;54(11):1001–8.
27. Rajput SA, Ashraff S, Siddiqui M. Diet and management of type II diabetes mellitus in the United Kingdom: a narrative review. Diabetology. 2022;3(1):72–8.
28. Degefa G, Wubshet K, Tesfaye S, Hirigo AT. Predictors of adherence toward specific domains of diabetic self-care among type-2 diabetes patients. Clin Med Insights Endocrinol Diabetes. 2020;13:1179551420981909.
29. Mohandas A, Bhasin S, Upadhyay M, Madhu S. Diabetes self care activities among adults 20 years and above residing in a resettlement colony in East Delhi. Indian J Public Health. 2018;62(2):104.
30. Adu MD, Malabu UH, Malau-Aduli AE, Malau-Aduli BS. Enablers and barriers to effective diabetes self-management: a multinational investigation. PLoS ONE. 2019;14(6): e0217771.
31. Grewal EK, Campbell RB, Booth GL, McBrien KA, Hwang SW, O'Campo P, et al. Using concept mapping to prioritize barriers

to diabetes care and self-management for those who experience homelessness. Int J Equity Health. 2021;20(1):158.
32. Stephani V, Opoku D, Beran D. Self-management of diabetes in Sub-Saharan Africa: a systematic review. BMC Public Health. 2018;18(1):1–11.
33. Iwuala S, Olamoyegun M, Sabir A, Fasanmade O. The relationship between self-monitoring of blood glucose and glycaemic control among patients attending an urban diabetes clinic in Nigeria. Ann Afr Med. 2015;14(4):182–7.
34. Kassahun A, Gashe F, Mulisa E, Rike WA. Nonadherence and factors affecting adherence of diabetic patients to anti-diabetic medication in Assela General Hospital, Oromia Region, Ethiopia. J Pharm Bioallied Sci. 2016;8(2):124–9.
35. de-Graft Aikins A, Awuah RB, Pera TA, Mendez M, Ogedegbe G. Explanatory models of diabetes in urban poor communities in Accra, Ghana. Ethn Health. 2015;20(4):391–408.
36. Coffey L, Mahon C, Gallagher P. Perceptions and experiences of diabetic foot ulceration and foot care in people with diabetes: a qualitative meta-synthesis. Int Wound J. 2019;16(1):183–210.
37. Pourkazemi A, Ghanbari A, Khojamli M, Balo H, Hemmati H, Jafaryparvar Z, et al. Diabetic foot care: knowledge and practice. BMC Endocr Disord. 2020;20(1):1–8.
38. Adarmouch L, Elyacoubi A, Dahmash L, El Ansari N, Sebbani M, Amine M. Short-term effectiveness of a culturally tailored educational intervention on foot self-care among type 2 diabetes patients in Morocco. J Clin Transl Endocrinol. 2017;7:54–9.
39. Marinho FS, Moram C, Rodrigues PC, Leite NC, Salles GF, Cardoso CR. Treatment adherence and its associated factors in patients with type 2 diabetes: results from the Rio de Janeiro type 2 diabetes cohort study. J Diabetes Res. 2018;2018. https://doi.org/10.1155/2018/8970196
40. Alosaimi FD, Labani R, Almasoud N, Alhelali N, Althawadi L, AlJahani DM. Associations of foot ulceration with quality of life and psychosocial determinants among patients with diabetes; a case-control study. J Foot Ankle Res. 2019;12(1):1–11.
41. Amer FA, Mohamed MS, Elbur AI, Abdelaziz SI, Elrayah ZA. Influence of self-efficacy management on adherence to self-care activities and treatment outcome among diabetes mellitus type 2. Pharm Pract (Granada). 2018;16(4):1274.
42. Ketema DB, Leshargie CT, Kibret GD, Assemie MA, Alamneh AA, Kassa GM, et al. Level of self-care practice among diabetic patients in Ethiopia: a systematic review and meta-analysis. BMC Public Health. 2020;20(1):1–12.
43. Mutyambizi C, Pavlova M, Hongoro C, Groot W. Inequalities and factors associated with adherence to diabetes self-care practices amongst patients at two public hospitals in Gauteng, South Africa. BMC Endocr Disord. 2020;20(1):1–10.
44. Rajasekharan D, Kulkarni V, Unnikrishnan B, Kumar N, Holla R, Thapar R. Self care activities among patients with diabetes attending a tertiary care hospital in Mangalore Karnataka, India. Ann Med Health Sci Res. 2015;5(1):59–64.
45. Adhikari M, Devkota HR, Cesuroglu T. Barriers to and facilitators of diabetes self-management practices in Rupandehi, Nepal - multiple stakeholders' perspective. BMC Public Health. 2021;21(1):1269.
46. De Man J, Aweko J, Daivadanam M, Alvesson HM, Delobelle P, Mayega RW, et al. Diabetes self-management in three different income settings: cross-learning of barriers and opportunities. PLoS ONE. 2019;14(3): e0213530.
47. Liu Y, Jiang J, You W, Gong D, Ma X, Wu M, et al. Exploring facilitators and barriers to self-management engagement of Chinese people with type 2 diabetes mellitus and poor blood glucose control: a descriptive qualitative study. BMC Endocr Disord. 2022;22(1):294.
48. Pamungkas RA, Chamroonsawasdi K, Vatanasomboon P, Charupoonphol P. Barriers to effective diabetes mellitus self-management (DMSM) practice for glycemic uncontrolled type 2 diabetes mellitus (T2DM): a socio cultural context of Indonesian communities in West Sulawesi. Eur J Investig Health Psychol Educ. 2019;10(1):250–61.