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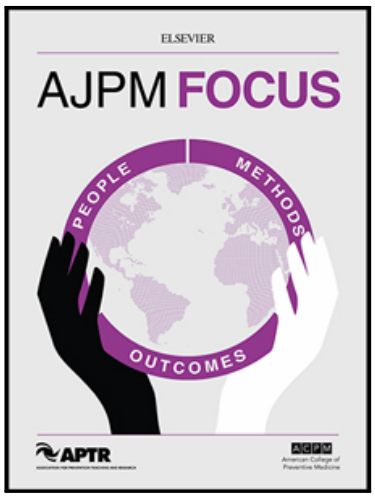

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Effectiveness of Diabetes Self-Management Education and Support on Glycemic Control and Diabetes-Related Outcomes in Africa: A Systematic Review and Meta-Analysis

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Highlights

- DSMES did not significantly reduce HbA1c in African diabetes patients
- Meta-analysis included 18 RCTs from diverse African countries
- High heterogeneity observed in glycemic outcome measures
- No significant effects on BMI, blood pressure, or lipid profiles
- Standardized DSMES models are needed in low-resource settings

Abstract

Introduction: Diabetes prevalence in Africa continues to rise, presenting significant health and economic challenges. Effective management strategies, such as Diabetes Self-Management Education and Support (DSMES), are crucial for improving clinical outcomes. However, the impact of DSMES on glycemic control and related metabolic parameters in African populations remains unclear.

Objective: This study evaluates the effectiveness of DSMES interventions compared to standard diabetes care in Africa, with a focus on glycemic control and secondary metabolic outcomes.

Methods: A systematic review and meta-analysis were conducted in accordance with the PRISMA guidelines. Comprehensive searches were performed in PubMed, Embase, CINAHL, Scopus, Web of Science, and PsycINFO, supplemented with regional sources such as Africa Journal Online (AJOL) and ProQuest. Randomized Controlled Trials (RCTs) published in English up to April 2024, involving adult participants with type 2 diabetes in Africa who received DSMES interventions, were included. The Cochrane Risk of Bias Tool 1 was used to assess study quality. Heterogeneity was evaluated using I^2 statistics, and random-effects models were applied for pooled estimates.

Results: Eighteen RCTs (2,599 participants) were included. DSMES interventions did not significantly improve glycemic control, with a pooled mean reduction in HbA1c of -0.25% (95% CI: -0.68 to 0.18; $p < 0.0001$). Fasting blood glucose outcomes, assessed in two studies, showed no significant difference (MD: -0.13, 95% CI: -0.37 to 0.12). Secondary outcomes (BMI, blood pressure, lipids) showed no significant changes. Sensitivity analysis excluding one study showed a larger effect

size (-0.42%, 95% CI: -0.76 to -0.07). Substantial heterogeneity (I^2 = 93.8%) was observed.

Conclusion: DSMES reveals a non-significant impact on HbA1c reduction in African adults with type 2 diabetes and emphasizes the need for more standardized approaches and broader outcome measures. Future studies should aim to refine DSMES models, enhance patient engagement, and evaluate a wider range of health outcomes to realize the full potential of DSMES in resource-limited settings.

Graphical abstract: Figure 6

Keywords: DSMES, Diabetes Education, HbA1c, Type 2 Diabetes, Africa, Glycemic Control, Self-Management, Low Resource Setting,

Introduction

Diabetes is a significant public health concern worldwide, with over half a billion adults currently affected.[1] More than three-quarters of people living with diabetes reside in low- and middle-income countries, where healthcare systems often face challenges in addressing the complexities of chronic disease management.[1] The African region is no exception, witnessing a significant rise in diabetes prevalence. Approximately 1 in 22 adults in the area were diagnosed with diabetes in 2021, with many more undiagnosed.[2] This escalating burden underscores the need for comprehensive strategies to combat the disease and its associated complications.

Effective diabetes management demands a multidisciplinary approach, involving healthcare providers, family members, and, most importantly, the individuals themselves.[3] Poorly managed diabetes can lead to severe complications, including cardiovascular diseases, kidney failure, and neuropathy, which significantly reduce quality of life and increase healthcare costs.[4] Diabetes Self-Management Education and Support (DSMES) has emerged as a cornerstone of diabetes care. The American Diabetes Association (ADA) defines DSMES as an evidence-based intervention that equips individuals with the knowledge, skills, and confidence needed to manage their condition effectively.[5] DSMES promotes informed decision-making, problem-solving, and sustainable self-care behaviors by fostering collaboration between patients and healthcare teams. Studies have consistently demonstrated that individuals participating in DSMES programs achieve better glycemic control, improved quality of life, and reduced healthcare costs compared to those receiving standard care alone.[6]

Despite its proven benefits in high-income settings, the implementation of DSMES in Africa faces unique challenges. The continent's diverse cultural, linguistic, and socioeconomic contexts complicate the delivery of standardized education programs.[7] Limited healthcare resources, a shortage of trained professionals, and low levels of health literacy further hinder the adoption of DSMES.[7] However, the potential of DSMES to address these challenges is

immense, particularly when interventions are tailored to local needs. For instance, community-based and peer-led models have shown promise in overcoming barriers to accessibility and affordability.[8]

Existing evidence on DSMES in Africa is limited but growing. Preliminary studies suggest that DSMES can improve diabetes-related outcomes, such as HbA1c levels and self-care behaviors, although results are often inconsistent due to variations in intervention design and delivery.[9] This systematic review and meta-analysis aim to synthesize available data on the effectiveness of DSMES in African settings to evaluate the effectiveness of DSMES on glycemic control and other diabetes-related clinical outcomes in type 2 diabetes patients and recommend actionable strategies to improve diabetes care across the region.

Materials and Methods

Study Design: A systematic review and meta-analysis following the PRISMA chart was conducted to evaluate the effectiveness of DSMES on clinical outcomes among patients with type 2 diabetes in Africa. The review included only Randomized Controlled Trials (RCTs) published in the English language. The review was registered with PROSPERO (Reg. No. CRD42023460051).

Search Strategy: We conducted a comprehensive literature search up to April 2024 to identify relevant studies evaluating the effectiveness of DSMES in Africa. The search was conducted across major electronic databases, including PubMed, Embase, CINAHL, Scopus, Web of

Science, and PsycINFO, with the inclusion of regional sources such as Africa Journal Online (AJOL) and ProQuest for grey literature.

The search strategy employed a combination of Medical Subject Headings (MeSH) terms and free-text keywords to capture all variations of DSMES interventions. Search terms included combinations of "Diabetes Self-Management Education," "DSMES," "Self-care education," and "Self-management support" alongside terms like "Type 2 Diabetes," "T2DM," "Africa," "Sub-Saharan Africa," and specific country names. Boolean operators were utilized to enhance the search scope. Manual searches of reference lists from relevant studies and citation tracking were also conducted to identify additional studies.

Inclusion and Exclusion Criteria: Studies were eligible for inclusion if they met the following criteria: (1) conducted in African settings, (2) focused on adult populations (≥18 years) with type 2 diabetes, (3) included structured DSMES interventions, (4) reported at least one clinical outcome such as HbA1c and, (5) published in the English language. Studies without a comparator group or lacking baseline and follow-up data were excluded.

To ensure methodological rigor and minimize bias, the predefined inclusion criteria restricted the review to Randomized Controlled Trials. Although some relevant non-randomized studies were initially identified, they were excluded during the screening phase. We recognize that this approach may have led to the omission of valuable evidence from well-conducted non-randomized studies, a limitation that is addressed in the discussion section.

Bias Mitigation: To minimize selection bias, two independent reviewers screened the titles and abstracts of identified studies. The full texts of potentially eligible studies were then assessed against the inclusion criteria, with discrepancies resolved through discussion or consultation with a third reviewer. Covidence software was employed to streamline the screening and data extraction processes, reducing human error and ensuring consistency. All extracted data were cross-verified by two reviewers, focusing on study characteristics, intervention components, and outcomes.

Study Selection: All identified citations were loaded into the EndNote referencing software, and duplicates were checked and auto-removed. The references were imported into Covidence software. The titles and abstracts were screened by two independent reviewers, and full texts were retrieved automatically by the Covidence software with only a few imported manually. In the same manner, the eligible studies included in the full text were critically assessed by two independent reviewers. Reasons for exclusion of full-text studies that do not meet the inclusion

criteria were recorded and reported. In both cases, discrepancies were resolved by consensus and a third reviewer.

Statistical Analysis

All statistical analyses were conducted according to a pre-specified plan developed prior to data extraction. Meta-analyses were conducted using the random-effects model to account for anticipated heterogeneity. This model was chosen a priori, recognizing the clinical and methodological diversity across included trials. We assessed statistical heterogeneity among studies using the I^2 statistic, which quantifies the percentage of total variation across studies due to heterogeneity rather than chance. An I^2 value of 0–25% was considered low, 26–50% moderate, and >50% substantial heterogeneity.

Sensitivity analysis was pre-planned to test the robustness of the primary outcome by excluding studies with a high risk of bias or statistical influence. Although no specific quantitative thresholds were pre-defined for exclusion, we assessed studies post hoc using visual inspection of forest plots and heterogeneity diagnostics. In particular, studies exhibiting extreme effect sizes and noticeably high influence on pooled estimates (based on their confidence interval width and visual leverage on summary effect) were considered for exclusion. This approach was applied cautiously to explore the impact of influential studies on overall findings. A funnel plot was used to assess potential publication bias; however, no formal tests for asymmetry were conducted due to the limited number of included studies per outcome. Analyses were performed using R software 4.1.0. All statistical tests were two-sided, and a p-value <0.05 was considered statistically significant.

Data Extraction and Quality Assessment: Data were extracted by two independent members of the review team using the Covidence Data Extraction Tool 1 for intervention studies. The data extraction was based on the review question/objectives and the inclusion criteria. This includes the study participants, settings, interventions, comparators, outcome measures, results, and other relevant data as captured in the data extraction tool. Quality assessment of included studies was assessed using the Cochrane Risk of Bias Tool 1 (**Supplementary Table 1**), focusing on seven criteria: sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessors, incomplete outcome data, selective outcome reporting, and other sources of bias. Each criterion was judged as "low," "high," or "unclear". Each study's methodological rigor was critically appraised, and publication bias was assessed through funnel plot symmetry (**Supplementary Figure 1**).

Qualitative description of the included studies

The characteristics of the included studies captured in **Table 1** present the following highlights:

Geographic Diversity: Studies were conducted across multiple countries, including Kenya, Tanzania, South Africa, Nigeria, Ethiopia, Rwanda, Egypt, Ghana, and Mali.

Study Designs: All the studies utilized randomized controlled trial designs, ensuring high internal validity for the reported outcomes. Sample sizes ranged from 77 to 275 participants, capturing a broad spectrum of participants with diverse demographic and clinical characteristics. The interventions included DSMES delivered by nurses, family integration, peer-led education, structured nutrition programs, intensive patient education, pharmacist-led interventions, and technology such as SMS-based reminders.

Inclusion Criteria: Most studies included adult participants diagnosed with type 2 diabetes, with HbA1c thresholds above 7% or 8%. Some studies required participants to demonstrate the ability to engage with specific intervention components, such as using SMS services or attending educational sessions.

Findings

At the identification level, a total of 1177 studies were imported for screening. In the screening phase, there were 623 studies reviewed, and 567 studies were found to be irrelevant and excluded from further consideration. A total of 56 studies were assessed for eligibility in the full text, and 38 studies were excluded for various reasons which including wrong study design, wrong setting, wrong patient population, wrong intervention, or outcome (**Supplementary Table 2**). Finally, 18 studies (**Table 1**), encompassing 2,599 participants, were included in the final analysis (**Fig. 1**).

Out of 18 studies, eleven have reported glycaemic outcomes (9 studies HbA1c and 2 studies Fasting Blood Sugar). The pooled effect size for HbA1c, based on a random-effects model across nine studies, was –0.25 (95% CI: –0.68 to 0.18), indicating no statistically significant improvement in glycemic control following DSMES interventions. Although the p-value for heterogeneity was <0.0001, reflecting substantial between-study variability, the primary analysis did not demonstrate a significant reduction in HbA1c (**Fig. 2**).

Table 1: Characteristics of the included studies

	Country	**Study aim**	**Total sample size** (Intervention/ Control allocated)	**Intervention**	**Inclusion criteria**	**Comparison groups**	**Duration of the interventions**	**Follow-up periods**
Gathu 2018	Kenya, United Republic of Tanzania	To assess the effects of DSME in comparison to usual diabetes care by family physicians	**140** Intervention 70 (8.9±1.89) Control 70 (9.3±1.75)	Controlled DSME	Recruited and screened patients from the FMC diabetes registry who had sub-optimally controlled type 2 diabetes, defined as HbA1c > 8%, and aged 18 to 65.	Standard diabetes care	One-hour education session every six weeks for 4 months	6 months
Muchiri 2015	South Africa	To evaluate the effect of a participant-customized nutrition education program on glycated Hb.	**82** Intervention 41 (9.8±0.3) Control 41 (10.4±0.3)	Received education materials and participated in the Nutrition Education program	At least one year of living with diabetes; regular attendance at the CHCs; blood sugar levels of > 10 mmol/L on two occasions in the previous six months and consequent HbA1c levels > 8% after blood analysis; non-pregnant and not on insulin therapy	The control group received education materials and continued with the usual medical care	Two-hour education session every eight weeks for 4 months	12 months
Essien 2017	Nigeria, the United Kingdom, and Northern Ireland	Intensive Patient Education Improves Glycaemic Control in Diabetes Compared to Conventional Education	**118** Intervention 59 (10.9±1.7) Control 59 (10.5±1.5)	Intensive Patient Education Program	Eligible patients (greater than or equal to 18 years, HbA1c > 8.5%, and physically able to participate) were randomly allocated by permuted block randomization to participate for six months in either an intensive or conventional education group.	Conventional education (There were no mobile phone reminder messages).	Two-hour education fortnightly over six months (12 structured teaching sessions)	6 months
Muchiri 2021	South Africa	To investigate the effectiveness of the adapted structured nutrition education program on clinical status,	**77** Intervention 39 (9.91±0.2) Control 38 (9.92±0.2)	Diabetes education materials and nutrition education program (NEP)	diabetic patients aged 40-70years, HbA1c of more than or equal to 8% living with diabetes for at least 1 year, Ability to understand	Diabetes education materials only.	Seven monthly group education sessions, bi-monthly group follow-up, and one	12 months

		dietary behaviors, and behavior mediators in adults with poorly controlled diabetes			English, Not pregnant		individual counseling session. All interventions were completed within one year.	
Ojewale 2022	Nigeria	to determine the effects of family-integrated diabetes education on the diabetes knowledge of patients and family members, as well as its impact on HbA1c	**170** Intervention 88 (7.8±2.1) Control 82 (7.5±1.8)	Family-Integrated Education Program and SMS	People Living with Diabetes (PLWD) and family members aged 18 years and over and without cognitive impairment were placed, as clusters, into either a control group (CG) or an intervention group (IG)	Standard care	Weekly education program for four weeks.	6 months
Diriba 2023	Ethiopia	To examine the preliminary effects of a culturally tailored, family-supported, community-based diabetes self-management education and support (DSMES) program for type 2 diabetes on HbA1c, blood pressure, BMI, and lipid profiles	**80** Intervention 40 (62±7.8) Control 40 (72±8.7)	Culturally tailored DSMES	People with type 2 diabetes were included if they:(1) were aged 18 years or over;(2) lived in two selected Kebeles in Nekemte; (3) were able to nominate primary family caregivers who could support them in diabetes management, and (4) were taking insulin and/or oral hypoglycaemic agents.	Usual care	Six 2-hour education programs	2 months
Ng'ang'a 2022	Rwanda	to assess the feasibility and effectiveness of implementing SMBG among insulin-dependent type 2 DM patients receiving care in three rural district hospitals in Rwanda.	**80** Intervention 42 (7.05±1.61) Control 38 (7.99±2.38)	Diabetes education with an SMBG kit to implement SMBG at home	Adults aged at least 18 years of age diagnosed with insulin-dependent type 2 DM and receiving an insulin regimen at the time of study at one of the three above-listed district hospitals were eligible. Eligible participants must have had the most recent HbA1C recording at 7% or greater.	Usual care	Weekly education for 3 months	6 months

Abaza 2017	Egypt	to examine the feasibility of SMS education among diabetic patients in Egypt, and assess the impact of educational text messages on glycemic control and DSM.	**90** Intervention 45 (9.78±2.53) Control 45 (9.53±2.78)	Diabetes care instruction booklet, educational SMS messages	Patients were included if they had diabetes, owned a mobile phone, and could read SMS messages or lived with someone who could read for them.	Diabetes care instruction booklet only	Daily educational SMS messages for 12 weeks	3 months
Eshete 2023	Ethiopia	to evaluate nutritional promotion interventions for dietary adherence and lessons learned to improve self-management.	**216** Intervention 108 (172.13±54.81) Control 108 (186.38±54.95)	Physical activity and nutrition promotion program	Patients aged 20 to 70, with no complications, who stayed for at least six months, and had no intention of leaving	Usual care	Weekly education for two months	6 months
Kiarie 2024	Kenya	To assess the comparative effectiveness of improved primary caregiver social support capacity on self-management practices of type II diabetes (T2D) clients in Machakos County, Kenya.	**275** Intervention 137 (8.93±3.55) Control 138 (10.55±5.72)	Implementing a diabetes care plan.	Clients diagnosed with T2D and enrolled in government-owned public health facility diabetes care and treatment programs in the Masinga and Matungulu sub-counties, between 18 and 65 years of age, who could read and write, and who lived with or near a person above 18 years who could serve as a primary caregiver	Usual care	Monthly self-management education for six months	6 months
Lamptey 2023	Accra, Ghana	Change in glycaemic control with structured diabetes self-management education in urban low-resource settings	**206** Intervention 103 (7.3±-1.5) CControl 103 (7.3±-1.5)	Structured DSME	Eligibility criteria included age 18 years or above, ability to participate in activities in a group setting, and being known to have T2DM. And not known to have chronic kidney or sickle cell disease.	Usual care only	Six hours of intensive group education	3 months

Debusscher 2018	Mali	to evaluate the effectiveness of peer-led self-management education in improving glycaemic control in patients with type 2 diabetes in a low-income country	**151** Intervention 76 (10.6±1.8) Control 75 (10.8±1.9)	Peer-led DSME	Patients included in the study were aged between 30 and 80 years, underwent regular follow-ups and monitoring in Bamako consultation units for poorly controlled T2D (HbA1c>8%), and agreed to have their clinical and biological measurements taken until completion of the protocol.	Standard care	1-2 hours peer education course delivered monthly for 9 months	12 months
David 2021	Nigeria	To evaluate the impact of pharmacist-led- led care on glycaemic control in patients with uncontrolled Type 2 Diabetes	108 Intervention 54 (7.3±None) Control 54 (8.0±None)	Pharmacist-led diabetes education intervention	i. Clinically diagnosed T2DM patients with greater than or equal to 7% A1c ii. patients with at least 6 months of regular clinic attendance before recruitment. iii. patients who were 18 years of age or older.	Usual care	30 – 45 minutes of initial education and at 3 months. Reinforce phone calls and SMS between	6 months
Hailu 2019	Ethiopia; Norway	To develop and test the effectiveness of a multifaceted, nurse-led DSME program for improving diabetes knowledge, self-care activities, and self-efficacy in an Ethiopian setting.	220 Intervention 116 (11.33±0.25) Control 104 (10.61±0.27)	Nurse-led DSME	T2DM patients 30 years of age or older at the time of diagnosis and who had used or were presently taking oral hypoglycaemic agents or insulin were eligible for inclusion in the study.	Routine diabetes care	Six interactive DSME sessions once a month for 6 months	9 months
Muchiri 2016	South Africa	To evaluate the effect of a nutrition education (NE) program on diabetes knowledge and attitudes of adults with type 2 diabetes mellitus	82 Intervention 41 (9.8±0.03) Control 41 (10.4±0.03)	Received education materials (pamphlet and wall/fridge poster) and participated in the Nutrition Education program	At least one year of living with diabetes; regular attendance at the CHCs; blood sugar levels of â‰¥ 10 mmol/L on two occasions in the previous six months and consequent HbA1c levels â‰¥ 8% after blood analysis;	Education materials only and usual care	2 hours of weekly nutrition education for 8 weeks	12 months

					non-pregnant and not on insulin therapy			
Hailu 2021	Ethiopia	To evaluate the effect of a locally contextualized, nurse-led DSME program on psychosocial health and quality of life among people with type 2 diabetes in Ethiopia.	**220** Intervention 116 (27.0±9) Control 104	Nurse-led DSME	T2DM patients 30 years of age or older at the time of Diagnosis and those who had used or were presently taking oral hypoglycaemic agents or insulin were eligible for inclusion in the study.	Standard care	Six DSME sessions once a month for 6 months	3 months
Tamiru 2023	Ethiopia	To assess the effect of DSME on self-care knowledge and behavior among adult diabetic patients	**360** Intervention 180 (11.23±0.31) Control 180 (8.21±0.29)	DSME	Registered patients aged 18 years and above with type 2 DM attending diabetes follow-up clinics	Routine diabetes care	One hour of monthly education for 6 months	6 months
Githinji 2022	Kenya; United States of America	To improve diabetes knowledge, health beliefs, dietary intake, physical activity, and weight status among Kenyan adults.	**226** Intervention 116 (2.87±0.43) CControl 110 (1.4±0.69)	Diabetes education	Adults 18 years and older with type 2 diabetes, living within peri-urban communities in Embakasi constituency.	Standard care	3 hours daily education for five days, followed by phone SMS for 4 weeks	3 months

In the sensitivity analysis, after excluding the study by Hailu (2019), the meta-analysis demonstrated a pooled mean difference of -0.42 (95% CI: -0.76 to -0.07), suggesting a statistically significant reduction in HbA1c levels among participants in the intervention group compared to the control group despite heterogeneity (I^2 = 93.8%, I^2 = 0.1611, p <0.0001). (**Fig. 3**). In the sensitivity analysis, we excluded the study by Hailu (2019) due to its high influence and statistical leverage, identified through visual inspection of the forest plot and heterogeneity diagnostic.

Further analysis of two studies reporting fasting blood glucose values compared self-management diabetic patients to non-self-management patients. The random effects model yielded an overall mean difference of -0.13 (95% CI: -0.37 to 0.12), which was not statistically significant. Heterogeneity among the studies was moderate (I^2 = 44.6%, p = 0.1791), indicating variability in the study outcomes (**Fig. 4**)

The meta-analysis also examined the effects of self-management interventions on additional metabolic and cardiovascular parameters, including body mass index (BMI), blood pressure, total cholesterol (TC), and low-density lipoprotein (LDL) levels. The pooled MD from three studies for BMI was -0.91 (95% CI: -5.20 to 3.37), indicating no significant reduction. Similarly, no significant effects were observed from three studies for systolic blood pressure (SBP) (MD = -3.04, 95% CI: -14.97 to 8.89) and two studies for diastolic blood pressure (DBP) (MD = 1.30, 95% CI: -19.39 to 21.99). Regarding lipid profiles, total cholesterol showed a pooled MD of -0.20 (95% CI: -1.14 to 0.74) from two studies, and another two studies showed a pooled MD of 0.20 (95% CI: -0.75 to 0.35) for LDL levels, suggesting no significant changes. The heterogeneity (I^2) across these outcomes remained low, indicating consistency across studies (**Fig. 5**).

Publication Bias

Visual inspection of the funnel plot **(Supplementary Figure 1)** indicated a relatively symmetrical distribution of effect sizes, suggesting a low likelihood of publication bias. However, due to the limited number of studies, particularly for secondary outcomes, this should be interpreted with caution.

Discussion

The findings of this systematic review and meta-analysis highlight the potential of DSMES interventions to improve diabetes-related outcomes in African settings. However, the present meta-analysis evaluated the impact of Diabetes Self-Management Education and Support (DSMES) interventions on glycemic control, with pooled data from nine studies indicating a non-significant reduction in HbA1c. Despite growing interest in DSMES as a holistic

approach to diabetes care, the findings suggest limited efficacy in uniformly improving glycemic outcomes. This result contrasts with global studies, which have established DSMES as a cornerstone of effective diabetes care.[5,10-11] Similarly, the meta-analysis of the two studies that reported fasting blood glucose was not statistically significant. Given that only two studies reported on fasting blood glucose, the pooled analysis is limited in its interpretability.

Several factors may account for this result. First, the substantial heterogeneity across studies highlights methodological variability, including differences in intervention design, duration, delivery mode, and patient demographics. Such inconsistencies could attenuate observable effects and mask the benefits of DSMES in specific contexts. Secondly, variations in adherence and participant engagement may further dilute treatment effects, as DSMES relies heavily on sustained behavioral changes. It is also possible that the metrics used (primarily HbA1c) may not fully capture the breadth of DSMES's impact, which can extend to self-efficacy, psychological well-being, and healthcare utilization. Future research might consider multi-dimensional outcome assessments and explore which DSMES components yield the most consistent benefits.

The substantial heterogeneity in study outcomes suggests variability in the implementation, content, and delivery methods of DSMES programs.[17] This highlights the need for standardized, culturally adapted interventions that can be widely adopted in diverse African settings. For instance, interventions incorporating community-based, family-supported, or peer-led models have shown promise in addressing unique cultural and socioeconomic barriers in Africa.[7,12] These models leverage local resources and social networks to enhance patient engagement and adherence, making DSMES more accessible and sustainable in low-resource settings.

In the same vein, the study shows limited significant changes in secondary outcomes such as BMI, blood pressure, and lipid profiles, suggesting that DSMES interventions may require additional components, such as dietary modifications and physical activity promotion, to yield broader metabolic benefits.[13,18]

The inconsistent effects observed in fasting blood glucose measurements further suggest that DSMES efficacy may depend on participant adherence, duration of intervention, and the extent of healthcare support provided.[19]

The high level of heterogeneity in glycemic outcomes (I^2 = 93.8%) may be attributed to differences in study design, sample size, intervention duration, and participant

characteristics.[20] These variations emphasize the need for further research to identify key components of effective DSMES programs and optimize their delivery to enhance consistency and impact.

Several barriers to DSMES implementation in Africa persist. Limited access to trained diabetes educators, inadequate funding, and low health literacy among patients are significant obstacles.[7,14] Innovative solutions, such as the use of mobile health (mHealth) technologies, could help bridge these gaps. For example, SMS-based reminders and telehealth consultations have been shown to improve patient adherence and reduce costs, making them viable options for scaling up DSMES interventions.[15]

Our review included only RCTs, which may have excluded relevant evidence from non-randomized studies that could offer additional insight into real-world effectiveness. Furthermore, our restriction to studies published in English may have introduced language bias, potentially omitting relevant studies from Francophone, Lusophone, or Arabophone African countries. Lack of long-term follow-up data in most studies limits the ability to assess the sustained impact of DSMES on diabetes outcomes. Future reviews could consider multilingual search strategies or collaborations with experts fluent in Arabic, French, and Portuguese to enhance coverage of studies on the African continent.

The high heterogeneity observed in HbA1c outcomes (I^2 = 93.8%) highlights substantial variability across studies, likely due to differences in intervention formats, duration, cultural tailoring, educator training, and baseline glycemic status. We did not conduct subgroup analyses or meta-regression due to the limited number of trials per covariate, which limits our ability to explore sources of heterogeneity. The analysis of fasting blood glucose included only two studies, limiting statistical power and precision. The moderate heterogeneity (I^2 = 44.6%) also complicates interpretation. There is a need for standardized reporting in future primary studies to facilitate accurate analysis. In addition, most studies lacked long-term follow-up, making it difficult to assess the durability of DSMES effects over time. Future studies should incorporate follow-up periods of 12 months or more. While we used a funnel plot to explore publication bias, no formal asymmetry tests were conducted, as the small number of studies per outcome limits their statistical power. Additionally, the meta-analysis for fasting blood glucose was based on only two studies, reducing the robustness of the conclusions for that outcome. We were also unable to conduct subgroup analyses or meta-regression to explore potential sources of heterogeneity due to the lack of consistent subgroup-level data across studies. Furthermore, most included studies lacked

long-term follow-up, limiting our ability to assess the durability of intervention effects. Lastly, cost-effectiveness analyses are needed to inform resource allocation and policy decisions, particularly in low-resource settings.[8,16]

Conclusion

While DSMES remains a promising strategy for empowering individuals with diabetes, the current evidence in this study does not support a statistically significant improvement in glycemic control based on pooled HbA1c data. The high heterogeneity underscores the need for more standardized, context-sensitive interventions and better-defined outcome measures. However, successful implementation requires the incorporation of DSMES as a standard component of primary healthcare services, addressing systemic barriers, including training for educators, resource allocation, and cultural adaptations. Policymakers and healthcare providers should invest in scalable DSMES programs to mitigate the growing diabetes burden across the region.

Therefore, future studies should aim to refine DSMES models, enhance patient engagement, and evaluate a broader range of health outcomes to realize their full potential in diabetes management. Researchers should also focus on evaluating cost-effective delivery methods, addressing the long-term impact of DSMES on glycemic control and quality of life, and developing standardized metrics for measuring secondary outcomes such as BMI, blood pressure, and lipid profiles.

Declarations

- **Declaration of Interest**

The authors declare no relevant affiliations or financial involvement with any organization or entity that has a financial interest in or conflicts with the subject matter or materials discussed in this manuscript.

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- **Consent for Publication**

Consent for publication is not applicable, as the study does not include names, images, or videos of individual participants.

- **Availability of Data and Materials**

All data generated or analyzed during this study are available upon reasonable request.

- **Conflicts of Interest**

The authors declare no conflicts of interest related to this study.

- **Declaration of generative AI and AI-assisted technologies in the writing process**

During the preparation of this work, the author(s) used [Co-Pilot and ChatGPT] in order to [proofread, paraphrase, and check grammatical errors]. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

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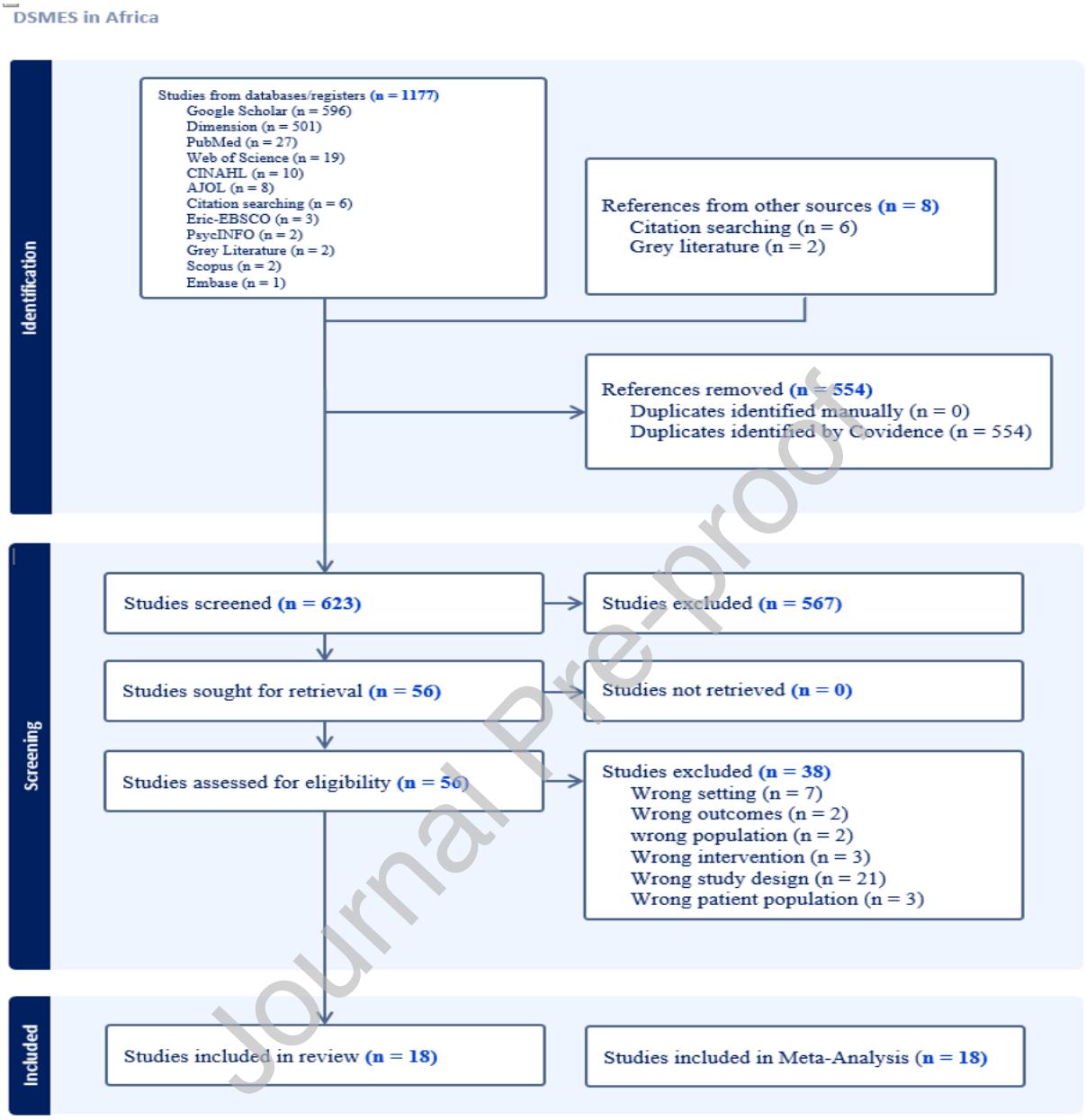


Figure 1: PRISMA Flow Chart

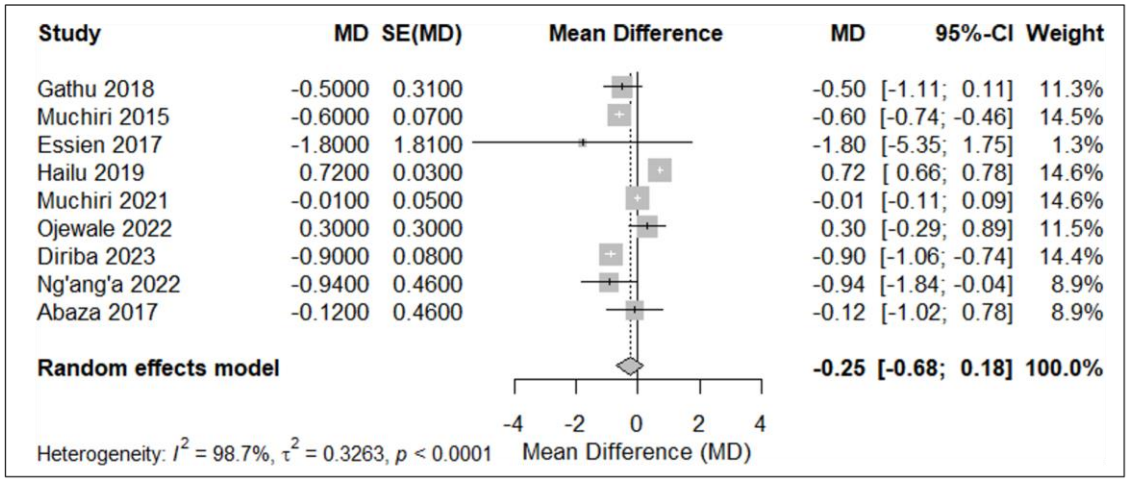
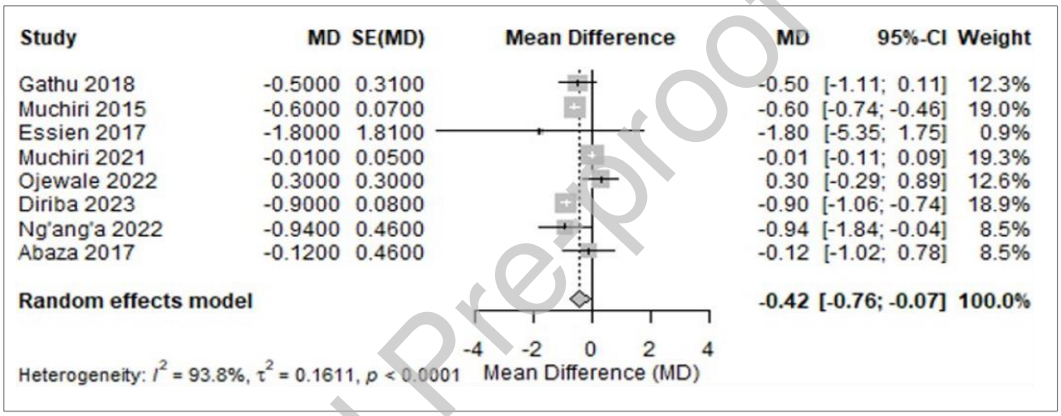


Figure 2: Meta-Analysis of the Effect of DSMES Interventions on HbA1c Levels in Diabetes Patients



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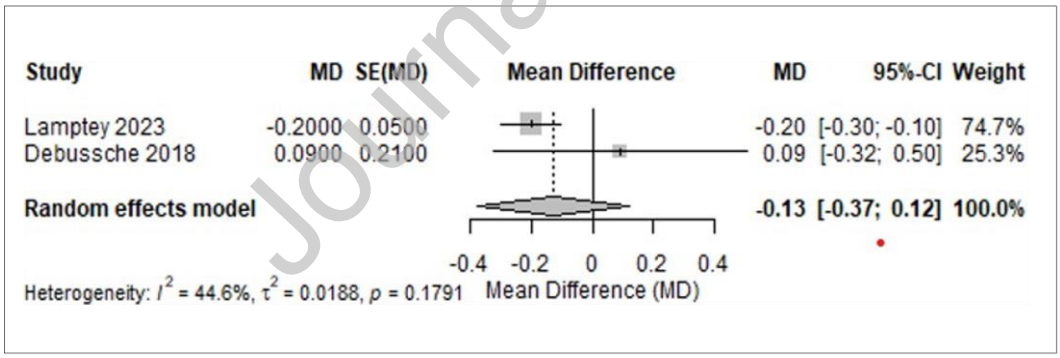

Figure 4: Meta-Analysis of the Effect of DSMES Interventions on Fasting Blood Glucose

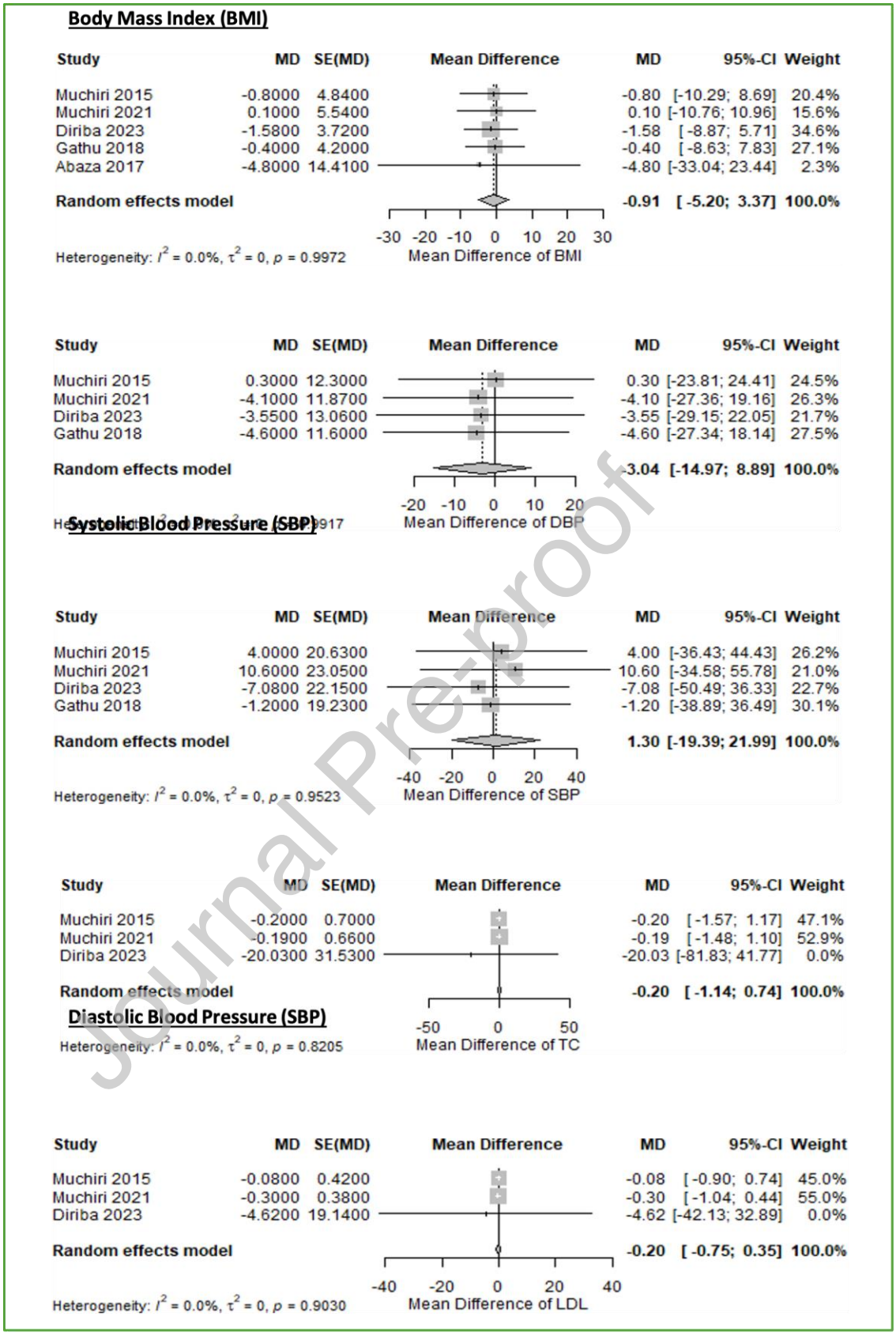

Figure 5: Meta-Analysis of the Effect of DSMES Interventions on Other Outcomes in Diabetes Patients

Author Contributions (CRediT) Statement

- **Nuhu Lawan Adamu**: Conceptualization, Methodology, Supervision, Writing – original draft, Validation, Project administration
- **Mohammed Merzah**: Formal analysis, Writing – review & editing
- **Daisy Iminza**: Investigation, Data curation, Writing – review & editing
- **Kwang Franky Tano**: Investigation, Data curation, Writing – review & editing
- **Taagbara Jolly Abaate**: Formal analysis, Visualization – review & editing
- **Parbati Thapa**: Supervision, Validation, Writing – review & editing

All authors reviewed and approved the final version of the manuscript.