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REVIEW

Impact of Pharmacist Interventions on Health Outcomes of Patients with Type 2 Diabetes Mellitus in the Middle East: A Systematic Review

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Abstract: This systematic review aimed to evaluate the association between pharmacists' interventions and health outcomes of patients with type 2 Diabetes Mellitus (DM) in the Middle East. A comprehensive database search was conducted in July 2024 using the electronic databases of PubMed, MEDLINE, Embase, Cochrane Library, Web of Science and Scopus. The search strategy involved the following keywords: "Impact", "Effect", "Pharmacist", "Pharmacy services", "Pharmaceutical Care", "Intervention", "Type 2 diabetes mellitus", "diabetes", and "Middle East". Articles published in the English language between January 2010 and July 2024 related to the research question were included. The data extracted from the included papers were summarized using narrative data synthesis. Twelve articles were selected from 536 retrieved articles, with most studies conducted in hospitals (n = 10) and randomized clinical trials (n = 8). The quality of studies was evaluated using the Cochrane risk of bias tool for RCTs and the Newcastle-Ottawa Scale for non-randomized studies to ensure transparent evaluation of the study quality. Narrative synthesis was employed to address variations in study design, outcomes, and biases. Pharmacist interventions reported included patient education (n = 11), counseling (n = 5), drug therapy initiation (n = 5), and dosage adjustment (n = 5). Studies reported significant reductions in glycosylated (HbA1c) (range: 1.4–1.78%) and fasting blood glucose levels (FBG) (range: 2.3–53 mg/dL), decreased systolic and diastolic blood pressure (range: 4.65–14.9 mmHg), body mass index (BMI) (range: 1–2.44 kg/m2), cholesterol, triglycerides, and total cholesterol, and improved medication adherence, self-care activities, and knowledge of diabetes management. In this review, pharmacist interventions reported were associated with improved clinical and humanistic outcomes among type 2 DM patients in the Middle-East. Therefore, collaborative care models involving pharmacists and other healthcare practitioners in the management of type 2 DM should be considered by health policymakers in the region.

Keywords: interventions, Middle East, pharmacist, pharmaceutical care, type 2 diabetes

Introduction

Diabetes mellitus (DM) remains an important public health problem.[1,2] It is a chronic metabolic disorder characterized by elevated blood glucose levels resulting from either inadequate insulin production or the body's inability to effectively utilize insulin.[3] The prevalence rate of DM is increasing worldwide.[2] In 2015, an estimated 415 million people suffered from DM globally, with a prevalence of 8.2% among the adult population. Even so, the burden of DM is projected to increase beyond 592 million by 2035.[4] DM is associated with high morbidity, mortality, and economic burden.[5] Globally, DM has been linked to over 4.2 million deaths in individuals aged 20 to 79.[6] According to the International Diabetes Federation, approximately US$465 billion was spent in caring for people living with DM worldwide, and the figure is projected to increase to US$595 billion by 2030.[6] There is a rapid rise in diabetes cases around the world, driven by factors such as urbanization, sedentary lifestyles, and dietary changes.[4] This surge in the prevalence of DM has placed an enormous burden on healthcare systems,[7] thus necessitating effective management strategies to improve patient outcomes and reduce complications associated with DM.

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The prevalence of diabetes mellitus in the Middle East is rising at an alarming rate, posing significant challenges to healthcare systems in the region.[8–10] The variations in socioeconomic status, level of healthcare infrastructure, and access to healthcare services across countries in the Middle Eastern region significantly influence the outcomes of public health and implementations of various goal-oriented interventions in patient care.[10] Despite advances in medical treatments, many patients struggle to achieve optimal glycemic control, which is crucial for preventing complications associated with diabetes.[11,12]

DM in the Middle East is faced with a unique challenge of healthcare disparities in infrastructure, such as rural communities often lacking specialized diabetic clinics, access to endocrinologists, and cultural factors as compared to urban centers.[13] However, healthcare training and regulatory framework differences across countries also complicate standardized care delivery in this region. Pharmacists, as accessible healthcare professionals, have the potential to play a critical role in diabetes management. In recent years, pharmacists in different settings, including community and hospital pharmacies, have provided patient-oriented services targeted at improving therapeutic outcomes.[14] Studies have demonstrated that pharmacist interventions improved clinical, humanistic, and economic outcomes for patients with DM.[15]

Additionally, pharmacists play a key role in addressing medication adherence, an important factor in optimal DM control. Studies have highlighted that pharmacist intervention plays critical roles in not only improving clinical, humanistic, and economic outcomes for DM patients, but it also improves adherence through education on medication timing and administration.[16] While the Middle East faces unique challenges as a result of disparities in healthcare infrastructure and cultural factors, the global trends highlight the increased burden of DM in this region. Therefore, this systematic review aims to synthesize evidence on pharmacist-led interventions for type 2 DM in this region, addressing the region-specific policy development.[17]

Materials and Methods

Search Strategy

A comprehensive database search was conducted in July 2024 using the electronic databases of PubMed, MEDLINE, Embase, Cochrane Library, Web of Science and Scopus. These databases were selected since they are storage sites for published medical articles, including randomized controlled trials (RCTs) and observational studies. The search was conducted using the following keywords: “Impact”, “Effect”, “Pharmacist”, “Pharmacy services”, “Pharmaceutical Care”, “Intervention”, “Type 2 diabetes mellitus”, “diabetes”, and “Middle East”. The search string used for data retrieval in the PubMed database was as follows: Impact [MESH] OR Effect [tw] AND Pharmacist [MeSH] OR pharmacy services [MeSH] OR pharmacist intervention [tw] OR pharmaceutical care [Text Word] AND diabetes mellitus [MeSH] OR diabetes [tw] OR Type 2 diabetes [tw] OR Type 2 diabetes mellitus [MESH] AND Middle East [MESH]. The search covered the 17 countries in the Middle East, including Saudi Arabia, Lebanon, Israel, Jordan, Kuwait, Syria, Iraq, Iran, Bahrain, Qatar, Oman, United Arab Emirates, Yemen, Turkey, Palestine, Cyprus, and Egypt. Filters based on the selection criteria were applied during the database search. Subsequently, the search string was adapted as required for literature search in other databases in this review.

Selection Criteria

The selection criteria for the review were: (1) Studies focusing on patients diagnosed with type 2 DM in Middle Eastern countries, (2) Studies involving pharmacist-led interventions aimed at improving outcomes of diabetes management, (3) Studies with control group or any non-pharmacist-led intervention as a comparator, (4) Studies reporting outcomes including glycemic control, blood pressure, lipid profile, medication adherence, quality of life, incidence of diabetes-related complications, and economic outcomes (5) Studies that utilized RCTs, quasi-experimental, cohort, or case–control design, (6) Studies conducted in community pharmacies, hospitals, clinics, or any other healthcare setting, and (7) Studies published in English language between 2010 and 2024.

Study Selection

Two independent reviewers conducted the screening of retrieved articles. The screening process followed three steps: (1) title screening, (2) abstract screening, and (3) full-text screening. The title of all the papers retrieved from the databases were first examined to see if they met the selection criteria. Studies that passed the title screening were subjected to abstract screening by the reviewers. Irrelevant papers based on their title as well as duplicate articles were excluded before abstract screening. The abstract of the articles was assessed to determine if they qualify to be included in the review. After ascertaining the articles that met the inclusion criteria, their full-text was sourced. The full text of the articles was reviewed independently by the two investigators. Discrepancies observed during the article screening process were resolved through discussion and consultation of a third party. The reasons for the exclusion of some papers were documented during the screening process (Figure 1). Furthermore, to ensure that no important study was missed, the researchers manually searched the reference lists of included articles and review papers.

Data Extraction

A data extraction form or template was designed and tailored based on specific objectives and review questions. The data extraction form comprised study characteristics (authors, year of publication, country of origin, setting, study design), population characteristics (sample size, age, gender, type of diabetes), intervention details (type of intervention, duration and frequency of intervention, components of intervention), and the comparator (usual care, standard care, or control group). Two

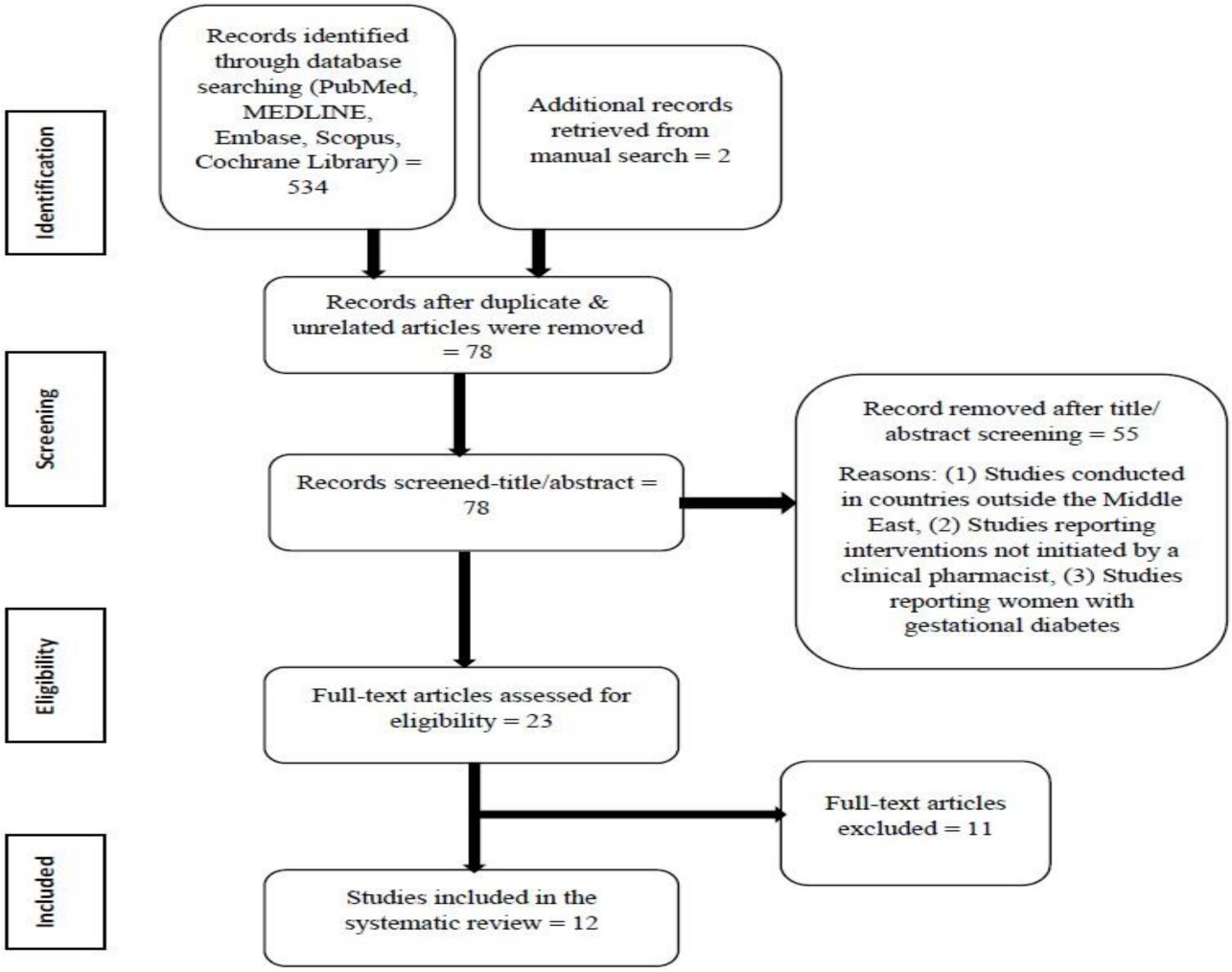

Figure 1 Flowchart of the literature search process.

independent reviewers were involved in the data extraction to minimize errors and bias. Discrepancies were resolved through discussion or consultation with a pre-determined expert in the field of study. In cases where some vital information is missing in an eligible study, the corresponding author of the paper was contacted to provide further information. Overall, the data extraction process followed the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines (Figure 1).

Risk of Bias Assessment

The quality of included studies was assessed using the Cochrane risk of bias (RoB) tool for RCT studies and the Newcastle-Ottawa Scale (NOS) for nonrandomized studies.[18,19] The Cochrane RoB tool is a critical instrument used to evaluate the risk of bias in randomized controlled trials (RCTs). The Cochrane RoB tool assesses various domains in RCT studies that could be a source of bias in research findings. The domains include: (1) selection bias (random sequence generation and allocation concealment), (2) performance bias (blinding of participants and personnel), (3) detection bias (blinding of outcome assessment), (4) attrition bias (incomplete outcome data), (5) reporting bias (selective outcome reporting), and (6) other biases are the domains contained in the tool. Each domain is assessed and assigned a judgment of "low risk", "high risk", or "unclear risk" based on predetermined criteria. A "low risk" judgment indicated that bias is unlikely to substantially affect the findings of the study, while a "high risk" judgment suggested that the bias might have a significant impact on the study outcomes. A domain was adjudged to have an "unclear risk" when there is limited information to guide the decision-making process. The overall risk of bias for an article was derived from the assessment scores of the individual domains.

The NOS assesses the quality of observation studies based on three criteria: (1) the selection of research groups, (2) the comparability of groups, and (3) the identification of either the exposure or outcome of interest.[19] The selection element of the scale evaluates the procedures used to choose study participants, including whether the participants were chosen relatively and impartially and whether they accurately represented the population of interest. The comparability component determines whether the study's groups are comparable regarding essential traits like age and sex. This part also evaluates whether the study considered potential confounding variables like smoking or other health issues. The outcome component evaluates the procedures used to measure the desired outcome, including whether it was measured consistently and objectively and whether the study's results were presented understandably and transparently. Each paper was graded between 0 and 9, with a higher score suggesting a higher quality study. If an item received three or four stars in the selection component, one or two stars in the comparability component, and two or three stars in the outcome domain, it was deemed to be of "good quality". An article was adjudged to have "fair quality" if it received two stars in the selection component, one or two stars in the comparability component, and two or three stars in the outcome component. An article was deemed to have "poor quality" if it received either zero or one star in the selection domain, zero in the comparability component, or zero or one star in the outcome domain.

Data Synthesis

Narrative synthesis was used to analyze retrieved data from all included papers. The narrative synthesis was considered because of the perceived heterogeneity in study designs, populations, interventions, and outcomes measure, a meta-analysis was not feasible. Hence, narrative synthesis was used to identify patterns across different methodologies. The process involved the organization of retrieved data into meaningful groups based on specific criteria such as intervention type, study design, or outcome measures. The findings of the review were subsequently summarized and analyzed within the group while identifying patterns, similarities, and differences.

Registration/Approval

This systematic review has been registered and approved by PROSPERO with registration number (CRD42024573611).

Results

Study Characteristics

Table 1 shows the characteristics of the reviewed studies. The findings showed that twelve studies were included in this review out of the 536 retrieved articles, giving a total sample size of 1604. The included papers were published between 2009 and 2022.

Table 1 Study Characteristics

Author	Year	Country	Setting	Study Design	Sample Size	Age (Years)	Gender
Ahmad et al,[25]	2015	Sudan	Nyala Teaching Hospital, South Darfur State	Prospective RCT	Total = 300; IG = 200; CG = 100	Total = 51.8 ± 4.7	Male = 180, Female = 120
Ebid et al,[24]	2022	Egypt	Ahmed Maher Teaching Hospital, Cairo	Prospective RCT	Total = 100; IG = 50, CG = 50	Total = NA; IG = 53.8 ± 5.6, CG = 55.7 ± 6.9	Male = 68 Female = 32
Mahwi & Obied[30]	2013	Iraq	Diabetic Center, Sulaimani	Prospective RCT	Total = 123; IG = 62, CG = 61	Total = NA; IG = 52.0 ± 7.86, CG = 53.4 ± 10.81	Male = 38 Female = 85
Al Mazroui et al,[26]	2009	UAE	Zayed Military Hospital	Prospective RCT	Total = 240; IG = 120, CG = 120	Total = NA; IG = 48.7 ± 8.2, CG = 49.9 ± 8.3	Male = 166 Female = 74
Wishah et al,[22]	2014	Jordan	Jordan University Hospital	RCT	Total = 106; IG = 52, CG = 54	Total = NA; IG = 52.9 ± 9.6, CG = 53.2 ± 11.2	Male = 46 Female = 60
Abdulrhim et al,[27]	2019	Qatar	Qatar Petroleum Healthcare Center, Dukhan	Retrospective, multiple time series	Total = 96; IG = 96, CG = NA	Total = 49.8 ± 9.2; IG = NA, CG = NA	Male = 65 Female = 31
AlSubaie et al,[20]	2022	Saudi Arabia	Al wazarat Primary care Center, Riyad	Retrospective study	Total = 419; IG = 419, CG = NA	Total = 58.9 ± 0.59	Male = 160 Female = 259
Mouhtadi et al,[28]	2018	Lebanon	17 community pharmacies in 4 districts (North, Bekaa, Beirut, and Mount Lebanon)	Prospective longitudinal study	Total = 200; IG = 200, CG = NA	Total = 59 ± 11.0	Male = 120 Female = 80
Jarab et al,[23]	2012	Jordan	Royal Medical Services	RCT	Total = 171; IG = 85, CG = 86	IG = 63.4 ± 10.1, CG = 65.3 ± 9.2	Male = 97 Female = 73
Jahangard-Rafsanjani et al,[29]	2014	Iran	Nemooneh-Taleghani Community Pharmacy	RCT	Total = 85; IG = 45, CG = 40	IG = 57.3 ± 8.6, CG = 55.9 ± 8.7	Male = 34 Female = 51
Korcegez et al,[9]	2017	Cyprus	Public Hospital, Gazimagusa	RCT	Total = 152; IG = 75, CG = 77	IG = 61.80 ± 10.38, CG = 62.22 ± 9.54	Male = 37 Female = 115
Alqifari et al,[21]	2022	Saudi Arabia	King Fahad Specialist Hospital, Buraydah	Retrospective study	Total = 32; IG = 32, CG = NA	Total = 55.75 ± 10.72	Male = 11 Female = 21

Abbreviations: IG, Intervention Group; CG, Control Group; NA, Not Available; RCT, Randomized Controlled Trial.

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Two studies apiece were conducted in Saudi Arabia[20,21] and Jordan.[22,23] One study each was conducted in Sudan, Egypt, Iraq, UAE, Qatar, Lebanon, Iran, and Cyprus.[2,9,24–29] Ten of the reviewed studies were conducted in a hospital setting,[9,20–27,30] while two were conducted in community pharmacy settings.[28,29] Eight of the reviewed papers had RCT design,[9,22–26,29,30] three had a retrospective design,[20,21,27] and one was a prospective longitudinal design.[28] There were no control groups in four of the studies reviewed.[20,21,27,28]

Pharmacists' Interventions

Table 2 contained the type of pharmacists' interventions observed in the various studies that were reviewed. Patient education was the most frequently observed pharmacist' interventions provided for patients with type 2 DM in the Middle East. Eleven studies reported providing patient education as a way of improving glycemic control and other patient outcomes.[2,9,20,22,23,25–30] In five studies, clinical pharmacist-provided interventions included patient counseling,[21–24,28] drug therapy initiation,[21–24,27] and dosage adjustment.[20,22–24,26] In three studies, clinical pharmacists offered medication adherence support to encourage complete adherence to prescribed medications and lifestyle modifications among patients with type 2 DM.[9,22,23] Medication review as a pharmacists' intervention was reported in two papers.[9,20]

Impact of Pharmacists' Interventions on Health Outcomes

Tables 3 and 4 showed the impact of pharmacists' interventions on glycemic control and other health outcomes of patients with type 2 DM. Overall, the included papers reported the effect of pharmacists' interventions on clinical (eg, HbA1c, FBG, PPBG, BP, BMI, lipid profile) and humanistic (medication adherence, knowledge of diabetes, HRQoL, and self-care activities) outcomes. None of the studies reviewed observed the impact of pharmacists' interventions on economic outcomes. In terms of clinical outcomes, 11 studies observed a significant reduction in HbA1c level in favor of patients who received pharmacists' interventions.[9,20–28,30] According to one of the reviewed studies, pharmacists' interventions had no effect on patients' HbA1c level.[29] Similarly, eight studies reported a significant reduction in the mean FBG owing to pharmacists' interventions.[9,22–24,26–28,30] Six studies found that systolic blood pressure and diastolic blood pressure were significantly decreased among DM patients who received pharmacists' interventions.[9,20,23,25–27] Six articles observed that pharmacists' interventions improved the BMI of patients with type 2 DM.[9,20,22,24,26,29] However, two studies reported no significant effect of pharmacists' interventions on patients' BMI.[21,23] The effect of pharmacists' interventions on the lipid profile of patients with type 2 DM remains unclear. Although the findings of three studies demonstrated that pharmacists' interventions led to a significant reduction in LDL-C,[20,23,24] three other included articles observed no significant effect of

Table 2 Pharmacists' Interventions for Patients with Type 2 Diabetes Mellitus

Authors	Patient Education	Counseling	Drug Therapy Initiation	Dosage Adjustment	Medication Adherence Support	Medication Reconciliation	Medication Review	Drug Monitoring
Ahmad et al[25]	√							
Ebid et al,[24]	√	√	√	√				
Mahwi & Obied[30]	√							
Al Mazroui et al,[26]	√			√				
Wishah et al,[22]	√	√	√	√	√			
Abdulrhim et al,[27]	√		√			√		
AlSubaie et al,[20]	√			√			√	
Mouhtadi et al,[28]	√	√						
Jarab et al,[23]	√	√	√	√	√			
Jahangard-Rafsanjani et al,[29]	√							√
Korcegez et al,[9]	√				√		√	
Alqifari et al,[21]		√	√					

Table 3 Impact of Pharmacists' Interventions on Patients' Health Outcomes and Study Limitations

Authors	Findings	Limitations
Ahmad et al,[25]	Pharmacists' interventions improved PPBG at 3 (8.2 ± 2.2) and 6 months (7.1 ± 1.7). About 54.0% of patients at 6 months reached target PPBG level compared to 12.0% at baseline ($p = 0.001$). No significant changes in PPBG were observed in the control group ($p = 0.840$). The mean HBA1c, SBP, and DBP were significantly reduced for patients in the IG compared to CG at 6 months ($p < 0.05$). Patient satisfaction level significantly increased for the IG from 48.5% at baseline to 62.5% at end point ($p = 0.015$).	1) Lack of lipid profile data due to insufficient data and high cost
Ebid et al,[24]	HbA1c (%) improved from baseline in the IG compared to UC group ($p < 0.001$). Similarly, FBG was significantly reduced at 6 months from baseline in the IG than in the UC group (−46 vs −1.4, $p < 0.05$). There was significant mean reduction in total cholesterol, LDL-C, and TG for patients in the intervention group compared to the UC group. HDL-C significantly increased in the IG than UC group. BMI for patients in IG and increased for the UC group at 6 months ($p < 0.05$). Patients in the IG had better knowledge of DM than those in UC at 6 months ($p < 0.05$). Medication adherence and self-care monitoring improved in the IG than UC group ($p < 0.05$).	1) Relatively small sample size 2) Inability to follow up patients beyond 6 months to see if outcomes obtained would be sustained or changed
Mahwi & Obied[30]	HbA1c and FBG were significantly reduced at the end of the follow-up period in the IG compared to the CG ($p < 0.05$). Pharmacist Interventions improved medication adherence for patients in the IG compared to CG ($p < 0.05$).	1) Small sample size
Al Mazroui et al,[26]	Mean BMI significantly decreased in the IG at 12 months from baseline ($p < 0.05$), unlike in the CG ($p > 0.05$). Mean FBG and HbA1c significantly decreased in the IG than CG ($p < 0.001$). There were significant differences in the mean SBP and DBP between the IG and UC group at 4, 8, and 12-months post-interventions. Total cholesterol, LDL-C, and TG improved in both groups, favoring the intervention. HRQoL of patients in the IG improved over time, while it remained relatively constant in CG. Pharmacist interventions improved patients' knowledge of their medications compared to the CG. Medication non-adherence was reduced for the patients in the IG from 48.3% at baseline to 21.4% at 12 months, while in the CG, it was reduced from 49.1% to 32.5%.	NA
Wishah et al,[22]	The IG group (1.7%) had a significant mean reduction in HbA1c compared to the UC group (0.3%) ($p = 0.010$). The mean reduction in FBG level of the IG was significantly higher than in the UC group (53 mg/dL vs 1.6 mg/dL, $p < 0.05$). Knowledge of DM significantly improved for patients in the IG compared to UC ($p = 0.010$). At 6 months, medication adherence improved in IG compared to the UC group ($p = 0.010$). The IG reported better self-care activities (foot care, diet, exercise, self-monitoring of blood sugar) than the UC group ($p < 0.05$). Patients in IG had improved BMI compared to UC group ($p < 0.05$). No difference in lipid profile between the IG and UC group ($p > 0.05$).	1) Participants were drawn from a single hospital-based DM clinic 2) Relatively small sample size 3) Use of self-reported scales 4) Six months follow-up was not enough to determine long-term effect of the interventions.

(*Continued*)

Table 3 (Continued).

Authors	Findings	Limitations
Abdulrhim et al,[27]	There was significant reduction in HbA1c (1.4%, p < 0.001) and FBG (2.3 mmol/L, p < 0.001) at 12 months from baseline. SBP and DBP significantly decreased by 14.9 mmHg and 8.7 mmHg, respectively, at 12 months from baseline. The BMI was significantly reduced (1 kg/m2) at 12 months from the baseline. There were no significant changes in the lipid profile (LDL-C, HDL-C, triglycerides, and total cholesterol).	1) No parallel control group 2) Some patients had received the intervention before baseline measurement 3) Follow-up of 12 month may not be adequate to assess long term effect of intervention
AlSubaie et al,[20]	HbA1c level was significantly decreased at 3 months (1.69%, p < 0.001) and at 6 months (1.78%, p < 0.001) compared to baseline. The LDL-C significantly decreased at 3 months (0.24 mmol/l, p < 0.001) and at 6 months (0.28 mm0l/l, p < 0.001). TG improved significantly at 3 months from baseline. Mean SBP improved after 6 months from baseline. Body weight and BMI improved at 3 month and 6 months from the baseline (p < 0.001). No difference in DBP at 3 and 6 months from baseline (p > 0.05).	1) Co-management of patients by a multidisciplinary team could have affected the study outcomes 2) No control group
Mouhtadi et al,[28]	The mean FBG significantly decreased at 12 months compared to the baseline (155 mg/dl vs 125 mg/dl, p < 0.001). The HbA1c was significantly reduced after 12 months of follow-up compared to the baseline (6.8 ± 0.9% vs 7.5 ± 1.4, p = 0.040). Patients' medication adherence improved at 12 months compared to baseline (84%) vs 64%, p = 0.001). Patients' adherence to balanced diet improved from 72% to 84% (p = 0.001) and regular exercise increased from 60% to 80% (p = 0.003).	1) Lack of a control group 2) Use of self-reported medication adherence tool prone to recall bias 3) Small sample size 4) Short duration of follow-up
Jarab et al,[23]	HbA1c significantly decreased in IG compared to the UC group (p = 0.019). The mean FBG significantly decreased in the IG (−2.3 mmol/l) than UC group (+0.9 mmol/l) from baseline (p = 0.014). The mean SBP and DBP were significantly reduced for patients in the IG compared to the UC group. Total cholesterol, LDL-C, and TG were significantly decreased in the intervention group than in the UC group (p < 0.05). No difference in HDL-C level and BMI were observed between the IG and UC group. Improved self-care (diet, exercise, SMBG) was observed in the IG compared to the UC group (p < 0.05).	1) Use of self-reported medication adherence tool 2) Small sample size 3) Short follow-up duration to determine sustainability of short-term effect
Jahangard-Rafsanjani et al,[29]	There was no difference in HbA1c level at the end of the trial period between the IG and the CG. The IG had significantly lower BMI compared to the CG. The IG had better medication adherence compared to the control group. Self-care domains including general diet, blood glucose monitoring, and foot care improved significantly in the intervention group than the control group.	1) Small sample size 2) Follow-up duration was relatively short
Korcegez et al,[9]	HbA1c and FBG were significantly reduced in the intervention group compared to the UC group (p < 0.05). The intervention group had significant reduction in SBP and DBP than the UC group (p < 0.05). Total cholesterol was significantly reduced in the IG compared to the UC group. There were no differences in LDL-C, HDL-C, and TG. BMI was significantly reduced in the IG relative to the UC group. Medication adherence and self-care activities (diet, SMBG, total foot care) was significantly improved in the IG versus UC group.	1) Single study center and small sample size affects generalizability of study findings

(*Continued*)

Table 3 (Continued).

Authors	Findings	Limitations
Alqifari et al,[21]	There was a significant reduction in HbA1c after 9 months compared to the baseline (10.30 ±. 1.66 vs 9.33 ± 1.80, p = 0.017). No significant difference was observed in the BMI at 9 months from the baseline (31.23 ± 4.68 vs 30.10 ± 5.75, p 0.258).	1) Single study center affects external validity 2) Small sample size 3) Inability to assess medication adherence

Abbreviations: DM, Diabetes Mellitus; FBG, Fasting Blood Glucose; HBA1c, Glycosylated hemoglobin; IG, Intervention Group; CG, Control Group; UC, Usual Care; BMI, Body Mass Index; LDL-C, Low Density Lipoprotein Cholesterol; HDL-C, High Density Lipoprotein Cholesterol; TG, Triglycerides; BP, Blood Pressure; SBP, Systolic Blood Pressure; DBP, Diastolic Blood Pressure; SMBG, Self-Monitoring Blood Glucose.

Table 4 Summary of the Impact of Pharmacists' Interventions on the Health Outcomes

Authors	HbA1c	FBG	PPBG	BP	BMI	LDL-C	HDL-C	TG	TC	MA	DK	SCA	HRQoL
Ahmad et al,[25]	√		√	√									
Ebid et al,[24]	√	√			√	√	X	√	√	√	√	√	
Mahwi & Obied[30]*	√	√								√			
Al Mazroui et al,[26]	√	√		√	√		√	√	√	√	√		√
Wishah et al,[22]	√	√			√	X	X	X	X	√	√	√	
Abdulrhim et al,[27]*	√	√		√		X	X	X	X				
AlSubaie et al,[20]*	√			√	√	√		√		√		√	
Mouhtadi et al,[28]	√	√											
Jarab et al,[23]	√	√		√	X	√	X	√	√			√	
Jahangard-Rafsanjani et al,[29]	X				√					√		√	
Korcegez et al,[9]	√	√		√	√	X	X	X	√	√		√	
Alqifari et al,[21]*	√				X								

Notes: *No Control Group.
Abbreviations: √, Pharmacists' intervention significantly improved outcome; X, pharmacists' interventions had no significant effect on outcome; HbA1c, Glycosylated hemoglobin; FBG, Fasting Blood Glucose; PPBG, Postprandial Blood Glucose; BP, Blood Pressure; BMI, Body Mass Index; LDL-C, Low Density Lipoprotein Cholesterol; High Density Lipoprotein Cholesterol; TG, Triglyceride; TC, Total Cholesterol; MA, Medication Adherence; DK, Diabetes Knowledge (including knowledge of diabetes & its medications; SCA, Self-Care Activities (eg, healthy diet, exercise, foot care, glucose monitoring).

the interventions on LDL-C.[9,22,27] Only one study documented an improvement in HDL-C in favor of pharmacists' interventions.[26] Four studies found that triglycerides[20,23,24,26] and total cholesterol[9,23,24,26] were significantly decreased among DM patients who received the interventions. Some studies, however, observed that pharmacists' interventions had no significant effect on triglycerides[9,22,27] and total cholesterol.[22,27] In view of the effect of pharmacists' interventions on humanistic outcomes, seven studies documented that the interventions led to an improvement in medication adherence among patients with type 2 DM.[9,20,22,24,26,29,30] Patients' knowledge of diabetes and its treatment was significantly improved by pharmacists' interventions based on the finding of three studies.[22,24,26] Additionally, six studies reported an improvement in self-care activities, including foot care, self-monitoring of blood glucose, exercise, and healthy diet in favor of pharmacists-provided interventions.[9,20,22–24,29] Improvement in the health-related quality of life of patients with type 2 DM as a consequence of pharmacists' interventions was reported in one study.[26]

Quantitative Summary of the Impact of Pharmacists-Led Interventions

Table 5 contains a quantitative summary of the impact of pharmacist interventions on outcomes of patients with DM. The findings revealed that pharmacist-led interventions improved clinical and behavioral outcomes in patients with diabetes. Specifically, pharmacists' involvement was associated with substantial reductions in HbA1c (91.7%) and fasting blood glucose (75.0%), indicating improved glycemic control. Positive effects were also observed in medication adherence (50.0%), body mass index (50.0%), and blood pressure regulation (SBP: 50.0%, DBP: 41.7%). While lipid profile improvements were modest, with reductions in LDL-C (33.3%), triglycerides (25.0%), and total cholesterol (25.0%), the findings suggest that pharmacists play a crucial role in comprehensive diabetes management. However, patient-reported

Table 5 Quantitative Summary of the Impact of Pharmacist Interventions Across the Studies (n = 12)

SN	Study Outcomes*	Frequency	Percent
1	Reduced FBG	9	75.0
2	Reduced HbA1c	11	91.7
3	Increased medication adherence	6	50.0
4	Reduced BMI	6	50.0
5	Reduced LDL-C	4	33.3
6	Increased HDL-C	1	8.3
7	Reduced triglycerides	3	25.0
8	Reduced total cholesterol	3	25.0
9	Reduced SBP	6	50.0
10	Reduced DBP	5	41.7
11	Patient satisfaction	1	8.3
12	Self-care	5	41.7
13	HRQoL	1	8.3
14	Knowledge of DM	1	8.3

Note: *Statistically significant improvement in the study outcome.
Abbreviations: BMI, Body Mass Index; DBP, Diastolic Blood Pressure; FBG, Fasting Blood Glucose; HbA1c, Glycosylated Haemoglobin; HDL-C, High Density Lipoprotein Cholesterol; HRQoL, Health-Related Quality of Life; LDL-C, Low Density Lipoprotein Cholesterol; SBP, Systolic Blood Pressure.

outcomes including HRQoL, self-care, and patient satisfaction were less frequently documented, warranting further research to assess the broader psychosocial benefits of pharmacist interventions.

Discussion

In this review, pharmacists' interventions improved the clinical and humanistic outcomes for patients with type 2 DM in the Middle East. Eleven studies demonstrated that pharmacists' interventions lower HbA1c and FBG glycemic markers.[9,20–28,30] For instance, Wishah et al reported that patients in the intervention group had a significant mean reduction in HbA1c compared to the UC group (1.7% vs 0.3%), while the mean reduction in FBG level of patients in the intervention group was significantly higher than in the UC group (53 mg/dL vs 1.6 mg/dL).[22] Similarly, another study found that HbA1c and FBG were significantly reduced by 1.4% and 2.3 mmol/L at 12 months from baseline, respectively.[27] This finding is consistent with the results of a previous meta-analysis of the impact of pharmaceutical care on glycosylated hemoglobin of patients with type 2 DM.[31] In the meta-analysis of RCT involving 2325 patients, pharmaceutical care led to a significant reduction in glycated hemoglobin (−1.07%; 95% CI: −1.32; −0.83).[31] Similarly, another meta-analysis involving thirteen RCTs found that pharmaceutical care interventions significantly decreased the HbA1c in the intervention group (Standard Mean Difference = −0.97; 95% CI −1.21 to −0.73; P = 0.001) as compared to the control group.[32] An RCT study in Nigeria evaluating the effect of pharmaceutical care on health outcomes of patients with type 2 diabetes found that the mean FBG significantly decreased from 262.4 ± 11.7 mg/dl to 144.9 ± 24.5 mg/dl.[33] Additionally, a mean reduction in glycosylated hemoglobin and FBG have been associated with pharmacists' interventions in other related studies.[34–36] This systematic review highlights the crucial role of pharmacists in managing type 2 diabetes through patient education, counselling, and medication adherence, thereby improving glycaemic control.

Lower levels of HbA1c and FBG have been associated with a decreased risk of diabetes-related complications, such as cardiovascular diseases, renal impairment, and retinopathy.[37] Hence, incorporating pharmacists into the diabetes care team can improve the clinical outcomes of patients with diabetes.

The present study found that pharmacists' interventions were linked to a reduction in systolic and diastolic blood pressure in six studies.[9,20,23,25–27] This finding agrees with those of previous studies. For example, Nogueira et al found that pharmaceutical care-based interventions significantly decreased the levels of systolic blood pressure (SBP) and diastolic blood pressure (DBP) for patients in the intervention group compared to those receiving standard or usual care

(−4.65 mmHg; 95% CI: −8.9; −0.4).[31] A similar finding was observed in another study in which pharmacists' interventions led to a reduction in the SBP (150.3 ± 29.4 mmHg to 127.0 ± 12.0 mmHg) and DBP (87.86 ± 20.1 mmHg to 80.98 ± 7.6 mmHg).[33] Recent reviews also demonstrated that pharmacists' interventions alone or in collaboration with other healthcare practitioners decreased the SBP levels of patients with type 2 DM.[38–40] The study emphasizes the crucial role of pharmacists in lowering blood pressure in type 2 diabetes patients, highlighting the need for optimal control of blood glucose and blood pressure, and suggests collaboration with other healthcare providers.

The effect of pharmacists' interventions on lipid profile of patients with type 2 DM yielded mixed findings. While some studies in the current review reported a decrease in LDL-C,[20,23,24] triglycerides,[20,23,24,26] and total cholesterol[9,23,24,26] due to pharmacists' interventions, other studies observed no substantial effect.[9,22,27] However, it seems that pharmacists' intervention had little or no effect on HDL-C, as only one study reported an improvement in HDL-C.[26] These findings are comparable to those of a previous review study in which the authors discovered that pharmacists' interventions decreased LDL-C, triglycerides, and total cholesterol in most of the included primary studies.[41] However, in contrast to the current review finding, the authors reported that nine out of twelve studies demonstrated an improvement in HLD-C levels as a result of pharmacists' interventions, including patient education and counseling, medication review, telemonitoring, and medication adherence support.[41] Another study also observed a significant reduction in the level of triglycerides and an increase in HDL-C among type 2 DM patients who received pharmacists' interventions.[31] Pharmacist intervention significantly reduces LDL-C, triglycerides, and total cholesterol levels in type 2 diabetes patients through personalized drug counselling, adherence assistance, lifestyle modifications, and routine monitoring. This reduces the risk of cardiovascular disease, a major contributor to morbidity and mortality.

Six out of eight included studies that investigated the effect of pharmacists' interventions on the BMI of type 2 DM patients discovered that the interventions had a positive effect on the BMI.[9,20–24,26,29] The findings of this review are in tandem with the result of a Malaysian study in which pharmacists' interventions led to a significant reduction in the BMI of patients with type 2 DM (29.34–28.92 kg/m2).[34] Likewise, pharmacist interventions have been linked to a BMI reduction among patients with type 2 DM in some previously published studies.[42–44] Obesity is a known predictor of microvascular complications in patients with type 2 DM through several mechanisms.[45,46] Higher BMI levels are associated with resistance to insulin and chronic inflammation. Insulin resistance and chronic inflammation worsen excessive accumulation of blood glucose in patients with type 2 DM, which is the main factor for the development of microvascular complications. Excessive fat deposits in the adipose tissues might lead to elevated fatty acids and pro-inflammatory cytokines, which have the potential to impair endothelial function and promote oxidative stress. The consequence of the disturbance in endothelial function is poor blood flow and damage to small blood vessels, thus, showing as complications in various organs. Additionally, HbA1c levels vary significantly in persons who are obese, and such variability is connected to an increased risk of these microvascular complications,[47] indicating that consistent glucose control is crucial in mitigating these risks.

Furthermore, the reviewed studies demonstrated that pharmacist interventions had a positive effect on the humanistic outcomes of patients with type 2 DM in the Middle East specifically, pharmacist interventions improved medication adherence,[9,20,22,24,26,29,30] knowledge of diabetes,[22,24,26] and self-care activities[9,20,22–24,29] among patients in the intervention group as opposed to those in the control group. By adopting various strategies including patient education, the use of information leaflets on diabetes and its management, drug monitoring, counseling on lifestyle adjustments, medication review, and medication adherence support, pharmacists are well-equipped to motivate and empower diabetic patients to assume responsibility for their physical and emotional well-being.[48,49] Near-perfect adherence to prescribed antidiabetic medications and lifestyle modifications is critical for achieving glycemic control in patients with type 2 DM. When the blood glucose is controlled optimally, it would contribute to risk reduction of cardiovascular events among this group of patients. This possibly explains the positive impact on humanistic outcomes observed in diabetic patients who were properly cared for by the pharmacist in collaboration with other healthcare providers.

Study Limitations

This review highlighted limitations that should be considered while interpreting its findings. First, the review combined both RCT and retrospective studies evaluating the impact of pharmacists' interventions on the health outcomes of patients with DM in the Middle East region. The included retrospective studies do not have control groups, and as such, this might affect the validity and generalizability of the study findings. Secondly, this review did not account for the

impact of a specific type of pharmacist intervention on patient outcomes through a sub-group analysis. However, almost all the studies utilized patient education in combination with one or more other strategies such as counseling, drug therapy initiation, dosage adjustment, telemonitoring services, and medication adherence support. Lastly, regional disparities in healthcare infrastructure and socioeconomic factors across Middle Eastern countries may impact intervention scalability and outcomes. Cultural factors, such as patient attitudes and lifestyle habits, also affect adherence and intervention success. Potential biases include publication bias and variability in pharmacist training or institutional support. This might limit the application of the study findings to other regions.

Conclusion

The findings of this systematic review suggest that pharmacist interventions improved HbA1c, FBG, BMI, lipid profile and humanistic outcomes of patients with type 2 DM in the Middle East. Patient education was identified as the most commonly utilized pharmacist intervention among this group of patients in the region. Therefore, formulation and implementation of policies promoting collaborative care models where pharmacists work together with physicians and other healthcare professionals in caring for patients with type 2 DM are recommended. This team-based strategy would ensure the delivery of comprehensive care and improved patient outcomes. Healthcare systems in the region should invest in developing and expanding pharmacist-led education programs in the interest of diabetic patients. These educational programs can focus on medication adherence, lifestyle modifications, and self-management skills to empower patients to manage their health conditions effectively.

Disclosure

The author declares no conflicts of interest in this work.

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