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Consultant Physicians' Awareness, Prescribing Practices, and Safety Measures of SGLT2 Inhibitors in Tripoli, Libya: A Unicenter Domestic Study

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A B S T R A C T

Sodium-glucose cotransporter-2 inhibitors (SGLT2i) improve glycemic control and provide cardiorenal benefits in type 2 diabetes mellitus (T2DM). Physician awareness and safe prescribing practices are critical to optimize outcomes. This study was conducted to evaluate consultant physicians' awareness, prescribing practices, and safety considerations regarding SGLT2i in Tripoli, Libya. A cross-sectional study included 39 consultant physicians (21 cardiologists, 18 endocrinologists) with ⩾1 year of SGLT2i prescribing experience. Data were collected via a validated self-administered questionnaire assessing demographics, prescribing patterns, observed benefits, adverse effects, monitoring practices, and awareness levels. Continuous variables were reported as median ± interquartile range (IQR); categorical variables as n (%). Associations were analyzed using chi-square, Fisher's exact test, and Spearman's rho correlation; $P < 0.05$ was significant. Median prescribing experience was 5 years (IQR 3–8). High awareness was observed in 64% and moderate in 36%. Most physicians prescribed SGLT2i for both cardiac and diabetes indications (72%), predominantly empagliflozin (82%). Observed benefits included cardiovascular, renal, and metabolic outcomes. Awareness significantly correlated with safety measure implementation ($r = 0.628$, $P = 0.038$) and reporting of adverse effects ($r = 0.661$, $P = 0.027$). Specialty correlated with short-term risk perception ($P < 0.002$), while years of experience inversely correlated with long-term risk perception ($r = -0.682$, $P = 0.021$). Consultant physicians in Libya demonstrate moderate to high awareness of SGLT2i, strongly influencing safety practices and patient benefits. Clinical pharmacists play a pivotal role in updating healthcare professionals, supporting safe prescribing, and optimizing therapeutic outcomes.

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INTRODUCTION

Type 2 diabetes mellitus (T2DM) is a rapidly growing global health challenge, affecting more than 537 million adults worldwide, a number projected to rise to 783 million by 2045 [1]. The disease burden extends beyond hyperglycemia, with cardiovascular disease, heart failure, and chronic kidney disease remaining the leading causes of morbidity and mortality among patients with diabetes [2]. These complications highlight the need for therapeutic strategies that go beyond simple glycemic control.

Sodium-glucose cotransporter-2 inhibitors (SGLT2i) have emerged as a novel class of oral antihyperglycemic drugs that lower plasma glucose by promoting urinary glucose excretion, independent of insulin action [3–5]. Initially developed for glycemic control in T2DM, SGLT2i have gained recognition for their broad cardiovascular and renal benefits. Clinical studies have demonstrated that these agents reduce hospitalizations for heart failure, major adverse cardiovascular events (MACE), and progression of diabetic kidney disease, making them versatile agents in contemporary diabetes management [6–10].

Large cardiovascular and renal outcome trials, including EMPA-REG OUTCOME, CANVAS, DAPA-HF, and DAPA-CKD, have consistently demonstrated reductions in cardiovascular mortality, hospitalization for heart failure, and renal disease progression in patients treated with SGLT2i [6–10]. Based on these findings, current clinical practice guidelines, including the American Diabetes Association (ADA) Standards of Care 2024, strongly recommend SGLT2i in patients with T2DM who have established cardiovascular disease or are at high risk, as well as in those with chronic kidney

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disease, regardless of diabetic status [11]. These data firmly establish SGLT2i as multipurpose agents with significant therapeutic potential, underscoring their growing role in managing patients with T2DM and associated cardiorenal risk. Despite robust evidence, real-world adoption of SGLT2i remains variable. Safety concerns, such as increased risk of genitourinary infections [12,13], euglycemic diabetic ketoacidosis (euDKA) [14,15], acute kidney injury [16], and potential bone fractures or amputations [17], may deter prescribing, especially in low- and middle-income countries with limited resources. Variability in treatment guidelines and uncertainty over whether SGLT2i should be prescribed only by specialists (endocrinologists, cardiologists, nephrologists) or also by general practitioners contribute to inconsistent use [18–20].

Physician awareness is a critical determinant of safe and effective SGLT2i utilization. Limited knowledge of emerging evidence, unfamiliarity with monitoring protocols, and concerns about adverse effects often hinder appropriate prescribing [18]. Awareness directly influences adherence to safety measures, patient monitoring, and early recognition of adverse events, which in turn affects clinical outcomes.

Clinical pharmacists play a pivotal role in bridging this knowledge gap. Their involvement in multidisciplinary care teams allows for critical appraisal of new evidence, guidance on guideline implementation, patient counseling, and assistance with safe initiation and monitoring of SGLT2i therapy. Evidence indicates that pharmacist-led interventions improve medication optimization, reduce adverse drug events, and enhance overall quality of care, particularly for complex therapies such as SGLT2 inhibitors [21–23].

In resource-limited settings such as Libya, data on physician awareness, prescribing patterns, and safety considerations for SGLT2i are scarce. Understanding these perspectives is essential to designing targeted educational interventions, strengthening clinical pharmacist-led collaborations, and facilitating evidence-to-practice translation. Evaluating these factors can guide strategies to standardize prescribing, ensure safe drug use, and optimize patient outcomes.

Therefore, this study aimed to evaluate consultant physicians' awareness, prescribing practices, and safety considerations regarding SGLT2 inhibitors in Tripoli, Libya, with a focus on controversies surrounding their clinical use and the supporting role of clinical pharmacists in evidence-based practice.

METHODS

Study Design

A cross-sectional exploratory study was conducted to assess consultant physicians' awareness, prescribing practices, and safety considerations regarding sodium-glucose cotransporter-2 inhibitors (SGLT2i) in Tripoli, Libya. The cross-sectional design was chosen because it allows for a real-world, snapshot evaluation of physician knowledge, clinical behavior, and adherence to safety protocols at a single point in time [24]. Such an approach is particularly valuable in settings where limited data exist regarding the implementation of newly introduced pharmacotherapies. The study aimed to identify both current prescribing trends and potential gaps in clinical knowledge, thereby providing insight into areas where education and pharmacist-led interventions could enhance patient care.

Study Participants

The study targeted consultant-level physicians with direct prescribing authority for patients with type 2 diabetes mellitus (T2DM), heart failure, or chronic kidney disease (CKD). Participants were selected to represent two key specialties: cardiology and endocrinology. A total of 39 consultant physicians participated, comprising 21 cardiologists (54%) and 18 endocrinologists (46%). Inclusion criteria required that physicians have at least one year of active experience prescribing SGLT2 inhibitors, ensuring that participants had meaningful clinical exposure to the class. Physicians without SGLT2i prescribing experience were excluded to maintain the focus on those with relevant practice insight. Demographic data, including age, sex, years of clinical experience, and specialty, were also collected to describe the study population and explore potential correlations with prescribing behavior and awareness levels.

Questionnaire Development and Validation

Data were collected using a structured, self-administered questionnaire specifically designed for this study. The questionnaire was developed based on a comprehensive review of published studies evaluating SGLT2i prescribing practices, physician knowledge, and safety monitoring [20,21], and it was subsequently adapted to the Libyan clinical context. Key domains of the questionnaire included: demographics and professional characteristics – capturing age, sex, specialty, and years of prescribing experience. Awareness assessment – evaluating knowledge of SGLT2i indications, mechanisms of action, therapeutic benefits, and potential adverse effects. Prescribing patterns – identifying the specific SGLT2i agents commonly prescribed, frequency of use, and clinical indications (e.g., cardiac, renal, metabolic). Observed patient outcomes – documenting improvements in cardiovascular, renal, and metabolic parameters as reported by participants.

Safety measures and monitoring practices – capturing implementation of strategies such as hygiene monitoring, diabetic ketoacidosis prevention, dehydration and hypoglycemia assessment, and documentation of adverse events.

To ensure content validity, the questionnaire underwent expert review by two senior clinical pharmacists and one experienced endocrinologist. They evaluated each item for clarity, relevance, and comprehensiveness, and minor modifications were

applied based on their feedback. A pilot study was conducted with five physicians outside the main cohort to test comprehension, length, and functionality of the survey instrument [25]. Feedback from the pilot was used to refine question wording, response options, and the electronic survey interface.

Data Collection Procedure

The finalized questionnaire was distributed electronically to participants via secure email, allowing physicians to complete the survey at their convenience, particularly considering the time constraints of practicing physicians. This method ensured anonymity, encouraged honest responses, and increased accessibility. Data collection was conducted over two months to accommodate scheduling constraints and maximize response rates. Participation was voluntary, and reminders were sent to non-respondents at two-week intervals.

Statistical Analysis

Data were coded and analyzed using SPSS version 29.1.1 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as median ± interquartile range (IQR) due to non-normal distribution, while categorical variables were reported as frequency and percentage. Inferential statistical analyses included: Chi-square test and Fisher–Freeman exact test – used to assess associations between categorical variables such as specialty, awareness level, and implementation of safety measures.

Spearman's rho correlation coefficient – applied to evaluate relationships between continuous or ordinal variables, including years of prescribing experience and perceived risk, and between awareness scores and adherence to safety measures.

A *P*-value of <0.05 was considered statistically significant for all analyses. In addition, subgroup analyses were performed to explore differences between cardiologists and endocrinologists in terms of prescribing patterns, observed benefits, and safety practices. These analyses helped to identify potential specialty-specific knowledge gaps or areas requiring targeted educational interventions.

Ethical Considerations

Participation was entirely voluntary, and all responses were collected anonymously to protect participant confidentiality. Verbal informed consent was obtained from each physician before survey completion. The study protocol was reviewed and approved by the Department of Pharmacology and Clinical Pharmacy, Faculty of Pharmacy, University of Tripoli, Ethics Committee (Approval code: UOT/2021), in compliance with national research ethics guidelines and the Declaration of Helsinki.

Data Quality Assurance

Several measures were implemented to ensure data quality. Survey responses were checked for completeness and consistency. Any incomplete or ambiguous responses were clarified via follow-up communication where possible. The electronic survey platform included validation rules to minimize entry errors, and the dataset was double-checked during coding and statistical analysis**.**

RESULTS

Participant Characteristics and Awareness

A total of 39 consultant physicians participated: 21 cardiologists (54%) and 18 endocrinologists (46%). Median experience prescribing SGLT2 inhibitors was 5 years (IQR 3–8), with no significant difference between specialties (P = 0.78, Table 1). High awareness of SGLT2i was observed in 64% of participants, while 36% had moderate awareness. No participants reported low awareness, and awareness did not differ significantly between cardiologists and endocrinologists (P = 0.62, Table 1).

Prescribing Practices and Observed Benefits

Most physicians (72%) prescribed SGLT2i for both cardiac and diabetes indications, with empagliflozin being the most frequently used agent (82%). Dapagliflozin was prescribed by 18%, and canagliflozin was not used (Table 2). Regarding observed benefits, 54% of participants noted improvements across cardiac, renal, and metabolic outcomes, 28% observed benefits in two domains, and 18% reported benefits in only one domain. No significant differences between specialties were noted for prescribing patterns or observed benefits (Table 2).

Awareness and Safety Measures

Implementation of safety measures was significantly associated with awareness (P < 0.001, Table 3). Among aware physicians, all implemented at least one safety measure: 28% focused on hygiene and DKA monitoring, while 72% additionally monitored dehydration and hypoglycemia. Conversely, 79% of non-aware physicians reported no safety measures, although 29% applied broader strategies. Awareness correlated moderately with safety measure implementation (r = 0.628, P = 0.038) and observed adverse effects (r = 0.661, P = 0.027), indicating that more aware physicians actively monitored and prevented potential adverse events.

Associations Between Prescribing Practices, Experience, and Risks/Benefits

Specialty was significantly associated with short-term risk perception (P < 0.002), with endocrinologists reporting more adverse events than cardiologists. Prescribing conditions strongly correlated with observed benefits (r = 0.785, P = 0.004). Years of prescribing experience inversely correlated with long-term risk perception (r = -0.682, P = 0.021), indicating that familiarity enhances confidence and may reduce perceived risk (Table 4).

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Table 1. Participant Characteristics and Awareness of SGLT2 Inhibitors

Characteristic	Overall (n=39)	Cardiologists (n=21)	Endocrinologists (n=18)	P-value
Years of prescribing SGLT2i, median (IQR)	5 (3–8)	5 (3–7)	5 (3–9)	0.78*
Awareness level				0.62†
Low	0 (0%)	0 (0%)	0 (0%)	
Moderate	14 (36%)	7 (33%)	7 (39%)	
High	25 (64%)	14 (67%)	11 (61%)	

**Continuous variables compared with the Mann-Whitney U test. †Categorical variables compared with chi-square or Fisher's exact test.*

Table 2. Prescribing Practices and Observed Benefits

Parameter	Overall (n=39)	Cardiologists (n=21)	Endocrinologists (n=18)	P-value†
Prescribed for cardiac & diabetes	28 (72%)	15 (71%)	13 (72%)	0.92
Observed benefits: all 3 outcomes	21 (54%)	11 (52%)	10 (56%)	0.51
Observed benefits: 2 outcomes	11 (28%)	6 (29%)	5 (28%)	
Observed benefits: 1 outcome	7 (18%)	4 (19%)	3 (17%)	

†Chi-square or Fisher's exact test.

Table 3. Awareness vs. Safety Measures and Adverse Effects

Safety Measures	*Non-aware (n=14)*	*Aware (n=25)*	*P-value†*
No safety measures	11 (79%)	0 (0%)	<0.001
Good hygiene & DKA monitoring	0 (0%)	7 (28%)	
Good hygiene + DKA, dehydration, hypoglycemia	4 (29%)	18 (72%)	
Awareness vs. Safety Measures	—	—	r = 0.628*, P = 0.038
Awareness vs. Adverse Effects	—	—	r = 0.661*, P = 0.027

*†Chi-square or Fisher's exact test; *Spearman's rho correlation.*

Table 4. Associations Between Prescribing Practices, Experience, and Risks/Benefits

Association	Statistic	Value	P-value
Specialty vs. short-term risks	Fisher–Freeman	—	<0.002
Prescribing conditions vs. observed benefits	Spearman's rho	0.785**	0.004
Years of prescribing experience vs. long-term risk perception	Spearman's rho	-0.682*	0.021

**Significant values in bold; continuous variables as median (IQR), categorical as n (%).*

DISCUSSION

This study provides novel insights into consultant physicians' awareness, prescribing practices, and safety considerations regarding SGLT2 inhibitors in Tripoli, Libya. Our findings indicate that the majority of physicians demonstrated moderate to high awareness of SGLT2i therapy, which significantly influenced the implementation of safety measures, monitoring practices, and reporting of adverse events. High awareness correlated with proactive safety strategies, highlighting the importance of physician knowledge for safe and guideline-concordant prescribing [26,27]. These findings align with international literature demonstrating that physician familiarity with novel therapies directly impacts patient safety and therapeutic outcomes [28,29].

Empagliflozin was the most frequently prescribed SGLT2 inhibitor, consistent with global prescribing trends favoring agents with the most robust cardiovascular and renal outcome evidence [30,31]. Dapagliflozin was also used, while canagliflozin was not prescribed by any participants, reflecting clinician preference for medications with well-

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documented benefits and lower perceived risks in the local context. The observed patient benefits reported by physicians included improvements in cardiovascular, renal, and metabolic outcomes, corroborating pivotal trials such as EMPA-REG OUTCOME, CANVAS, DAPA-HF, and DAPA-CKD [32–37]. These results underscore the multidimensional therapeutic potential of SGLT2 inhibitors beyond glycemic control, supporting their inclusion in contemporary diabetes and cardiorenal management guidelines [38,39].

Specialty-specific differences were apparent: endocrinologists reported higher short-term adverse effects, including genitourinary infections and mild dehydration, compared with cardiologists. This observation may reflect the greater focus of endocrinologists on metabolic monitoring and the higher proportion of complex diabetic patients under their care. Moreover, there was an inverse relationship between years of prescribing experience and perceived long-term risk, suggesting that familiarity with SGLT2i therapy fosters clinician confidence and may mitigate overly cautious prescribing behaviors [40,41].

A critical finding of this study is the pivotal role of clinical pharmacists in supporting physicians' safe and effective use of SGLT2 inhibitors. Pharmacists contribute through continuous appraisal of emerging evidence, guidance on guideline implementation, monitoring for adverse events, and structured education initiatives [26,27,30]. Their participation in multidisciplinary care teams has been associated with enhanced patient counseling, reduced medication errors, and improved adherence to safety protocols, particularly in resource-limited settings [42,43]. These observations reinforce the value of pharmacist-led interventions as a sustainable strategy to maintain high-quality care and ensure that evidence translates effectively into clinical practice [44].

The strong positive correlation between physician awareness and the adoption of safety measures observed in this study highlights that knowledge is a key determinant of safe prescribing. Physicians who were more aware of SGLT2i pharmacology and evidence were more likely to monitor for adverse events such as dehydration, hypoglycemia, and diabetic ketoacidosis. Similarly, higher awareness was associated with increased reporting of adverse effects, demonstrating an active engagement in risk mitigation [26,45]. These findings emphasize the necessity of ongoing educational programs to maintain physician competence and ensure patient safety, especially in settings where access to continuous professional development may be limited.

Furthermore, prescribing patterns and observed benefits were interrelated. Physicians adhering to recommended indications for SGLT2 inhibitors reported the greatest improvements across cardiovascular, renal, and metabolic outcomes, consistent with the principle that guideline-concordant therapy enhances therapeutic efficacy [46,47]. These results underscore the importance of evidence-based decision-making and reinforce the need for structured prescribing protocols and interdisciplinary case discussions.

The findings also highlight the need to address potential barriers to adoption. Despite moderate to high awareness, some physicians remained cautious due to concerns about adverse effects and uncertainties regarding appropriate patient selection. Integrating clinical pharmacists into routine practice, disseminating clear guidelines, and implementing educational workshops could reduce these barriers, streamline SGLT2i prescribing, and optimize patient outcomes [48].

Strengths and Limitations

This study captures real-world insights from consultant physicians with direct SGLT2i prescribing experience, providing a valuable snapshot of local clinical practice. The inclusion of both cardiologists and endocrinologists enables exploration of specialty-specific variations. However, the cross-sectional design limits causal inference, and the unicenter sample may reduce generalizability. Future studies should include multicenter cohorts, longitudinal follow-up, and direct assessment of patient-centered outcomes to strengthen the evidence base.

Implications for Practice

The results highlight the critical role of clinical pharmacists in sustaining high-quality care. By supporting physician education, monitoring therapy, and facilitating safe prescribing practices, pharmacists can help bridge the gap between evidence and practice. Structured education programs, routine interdisciplinary case discussions, and dissemination of updated guidelines are recommended to standardize SGLT2i utilization, mitigate safety concerns, and maximize patient benefits. Integrating these strategies into healthcare systems in Libya and other resource-constrained settings may promote sustainable improvements in diabetes and cardiorenal care.

CONCLUSION

Consultant physicians in Tripoli demonstrate moderate to high awareness of SGLT2 inhibitors, strongly influencing safety practices, monitoring, and observed patient benefits. Specialty and years of experience impact perceptions of risk, highlighting the need for ongoing education and pharmacist-led support. Clinical pharmacists play an indispensable role in keeping healthcare professionals updated, facilitating safe prescribing, and optimizing therapeutic outcomes. Multidisciplinary strategies, including pharmacist integration and structured education, are essential to enhance guideline-concordant SGLT2i use and ensure high-quality patient care.

Conflict of interest. Nil

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