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RESEARCH ARTICLE

Prevalence of Potentially Inappropriate Prescribing in Older Adults in Gulf Cooperation Council Countries: A Systematic Review and Meta-Analysis

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Abstract

Introduction Potentially Inappropriate Prescribing (PIP) poses a significant risk to patient safety and associated with poor healthcare outcomes in Gulf Cooperation Council (GCC) countries. This study aimed to assess PIP prevalence and patterns in older adults across all care settings in GCC.

Methods A comprehensive search was conducted on six medical databases to identify studies assessing the PIP prevalence in older adults using validated criteria in GCC. Pooled prevalence estimates and odds ratios were calculated using STATA Software (version 16). Statistical heterogeneity was evaluated with the I^2 statistic, and publication bias was assessed using funnel plot symmetry and Egger's regression test. The risk of bias was assessed using the JBI Prevalence Critical Appraisal Tool.

Results Fourteen eligible studies conducted over ten years included 18,647 patients. The median prevalence of PIP was 54.4% (IQR: 37.6–62.1%), higher in hospital settings (59.5%; IQR: 53.7–65.3%) compared to primary care (44.2%; IQR: 18.5–54.4%). Cardiovascular medications were the most common PIP (15,353 occurrences). Polypharmacy was significantly associated with PIP exposure (OR: 5.26; 95% CI: 2.33–11.84). The odds of PIP exposure were significantly increased among older individuals with chronic kidney disease (OR: 1.87; 95% CI: 1.19–2.54) and diabetes (OR: 1.74; 95% CI: 1.18–2.30).

Conclusion This study highlights high PIP prevalence among older adults in GCC countries, particularly in hospital settings. Polypharmacy and certain chronic conditions were significantly associated with PIP exposure. These findings emphasize the need for targeted interventions to improve prescribing practices and medication safety.

Keywords Inappropriate prescribing · Prescribing safety · Medication safety · Beers criteria · Systematic review · Meta-analysis · Elderly

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1 Introduction

The global population is experiencing a significant increase in the number of older adults, with projections indicating that by 2050, one in six people worldwide will be over the age of 65 [1]. This demographic shift highlights healthcare challenges faced by older adults, particularly in medication use. Older adults often contend with multiple chronic conditions and polypharmacy placing them at a heightened risk of potentially inappropriate prescribing (PIP) and adverse drug events [2, 3].

PIP is a prevalent issue among older individuals worldwide affecting all healthcare settings [4, 5]. It is associated with increased morbidity, reduced quality of life higher healthcare service utilization, and elevated costs [5, 6]. To detect and ensure appropriate prescribing in older patients, implementing validated criteria is essential [4]. Two commonly used types of criteria are explicit (criterion-based) and implicit (judgmental-based). Explicit criteria, such as the Beers criteria, Screening Tool of Older People's Prescriptions (STOPP) and Screening Tool to Alert to Right Treatment (START) criteria, are developed through literature review, expert opinion, and consensus techniques, providing a systematic framework with limited reliance on clinical judgment [7–9]. Implicit criteria, like the Medication Appropriateness Index (MAI), take a patient-centred approach, relying more on the prescriber's judgment and knowledge [10, 11]. Utilizing these criteria improves medication evaluation and enhances patient safety in older populations.

The Gulf Cooperation Council (GCC) countries, which include Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates (UAE), share common cultural, social, religious, and economic attributes [12]. Health systems in GCC countries are comparable and classified as high-income economies by the World Bank [13]. Despite the relatively low proportion of older adults, recent studies have revealed a high prevalence of PIP in these countries [14].

Over the past three decades, numerous systematic reviews have explored PIP in various countries across different healthcare settings. However, few have specifically focused on examining the prevalence of PIP, often limited to specific countries [15–17], measurement tools [18, 19], or healthcare settings [20–22]. Given the differences in country contexts and health systems between Western countries and the GCC region, it remains uncertain whether findings from these reviews can be generalized to the GCC.

To address this gap, we conducted a comprehensive and up-to-date systematic review to determine the prevalence and patterns of PIP in older adults across all care settings in GCC countries. This review is the first of its kind in the region and provides valuable insights across different settings in multiple countries.

2 Methods

2.1 Protocol and Guidance

The study protocol was prospectively registered on PROSPERO (registration no CRD42023439417) [23] and the review adheres to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement [24] as well as the Joanna Briggs Institute (JBI) methods [25].

2.2 Search Strategy

To identify relevant studies, a systematic search of six electronic databases (Ovid MEDLINE, EMBASE, PsycINFO, CINAHL Plus, SCOPUS, and Web of Science Core Collection) was conducted by AA and WK. The search covered the period from 1990 to April 2024 and included keywords such as "inappropriate prescribing," "inappropriate medication*," "screening tool of older person* prescriptions," "stopp/start criteria," "beers criteria," "medication appropriateness index*," and "Gulf Cooperation Council." Boolean operators (AND, OR, and/or NOT) were used to combine the terms in each database. The search was limited to English-language studies (see Supplementary file 1 for the full search strategy). In addition to the electronic search, the reference lists of included studies were screened to identify any additional relevant studies. Studies were eligible for inclusion if they measure the PIP prevalence using explicit or implicit tools in older adults aged 60 years and over in all care settings in GCC countries. Only primary studies published as full papers in peer-reviewed journals were included. All study designs were eligible for inclusion except for case-control studies, case series, and interventional studies. Studies that focused solely on a single disease or condition, as well as those that reported data exclusively on specific medications or classes of medications were excluded.

2.3 Study Selection and Data Extraction

All the initially identified studies were uploaded to Rayyan QCRI, a web and mobile app designed for systematic review screening and collaboration among reviewers for study inclusion and exclusion [26]. Five reviewers from the research team (RJ, SQ, TZ, RM, MT) independently screened the titles and abstracts of potentially relevant papers based on the selection criteria using the app. Subsequently, the full text of eligible studies was screened for

inclusion by at least two independent reviewers. Any disagreement about study inclusion were resolved with the involvement of another reviewers (AA and WK). Data was independently extracted from all eligible studies by two reviewers to ensure accuracy and consistency. Reviewer AA ensured all data extracted in the sheets. The following characteristics of the included studies were extracted: study details (author, year), study design, country, setting, number of sites, data collection, study period, medicine category (Rx, OTC), sample size, female (%), age (years), sample inclusion and exclusion criteria. We also extracted the number of medications (mean, standard deviation), prevalence of polypharmacy (%), used tool(s), tool adaptation, number of PIP, number of patients with at least one PIP, timing of outcomes measurement, risk factors, type of PIP, most common PIP medications, and study outcomes (primary/secondary), assessed population size, patient age and gender, duration of intervention and follow up, and study results.

2.4 Risk of Bias Assessment

The risk of bias in the included studies was assessed using the Joanna Briggs Institute (JBI) Prevalence Critical Appraisal Tool, which contains nine items: representativeness of the sample; appropriateness of recruitment; adequateness of the sample size; appropriateness of the description of the study subjects and setting; coverage bias; validity of the measurements; reliability of the measurements; appropriateness of statistical analysis; and adequateness of the response rate. Two authors were independently apply the tool to each included study. The overall risk of bias was rated as "Yes", "No", "unclear" or "Not applicable". A risk of bias summary was produced to report the quality of included studies.

2.5 Statistical Analysis

The collected data were inputted into Microsoft Excel, and all statistical analyses were conducted using STATA Software, version 16.1 MP (StataCorp, College Station, Texas, USA). Pooled prevalence estimates were reported with 95% confidence intervals (CI). Pooled odds ratios (OR) with corresponding 95% CI were calculated using the log transformation method, and inverse variance weights were determined for each study to identify the factors association between PIM exposure. The DerSimonian and Laird random-effects model was applied. Statistical heterogeneity was evaluated by calculating the I2 statistic. When I2 exceeded 50%, indicating substantial heterogeneity, subgroup analyses were performed to investigate the differences in the PIM exposure based on underlying chronic disease conditions. Publication bias was assessed by examining funnel plot symmetry and performing Egger's regression test.

3 Results

3.1 Search and Study Selection

The initial search yielded 1,051 studies (Fig. 1 shows the PRISMA flow diagram for this study). After removing duplicates and studies that did not match the inclusion criteria, 605 studies were searched based on their titles and abstracts. Of these studies, 523 were excluded, 82 studies underwent full-text screening. Among these, 68 studies were subsequently excluded due to reasons such as being conference abstracts, focusing on a single disease or condition, or lacking relevant outcomes. Ultimately, 14 studies were included in the systematic review [27–40]. Of these, 13 studies were included in the subsequent statistical analysis, while one study was excluded because it reported the number of prescriptions rather than the number of patients [34].

3.2 Study Characteristics

The studies analysed were conducted over a ten-year period from 2013 to 2022. The studies were carried out across five GCC countries involving a total of 18,647 patients. Most studies included participants aged over 65 years [27–30, 32–37, 39, 40], with only two studies included participants aged 60 years and over [38, 41]. Saudi Arabia was the most represented country with seven studies including 7,248 patients [28, 32, 34, 36, 38, 39, 41]. Qatar followed with three studies including 9,677 patients [30, 33, 40]. Kuwait had two studies with 843 patients [35, 37]. The UAE and Oman each had one study with 502 patients [27] and 377 patients [29], respectively. The most common setting of the included studies was hospitals (ten studies) [27, 28, 32, 34–36, 38–41], followed primary care settings (three studies) [29, 30, 37], and a home care setting [33]. Characteristics of the included studies are presented in Table 1.

Among the studies included in this study, two used more than one tool to identify PIP [29, 37], while the remaining 12 studies each employed a single tool. Of the 14 included studies, only one utilized implicit tools, specifically the Medication Appropriateness Index (MAI) [37]. The explicit tools used included various versions of the Beer criteria; 2003 [34], 2012 [28, 33, 38], 2015 [29, 30, 32, 37, 39], 2019 [27, 35, 36, 40, 41] as well as the STOPP version 1 [29], STOPP/START version 2 [37] and FORTA [37]. PIP medications in GCC countries, categorized by medication class, identified cardiovascular system medications were the most common PIP (15,353 occurrences), followed by gastrointestinal (8,003) and central nervous system medications (7,565). Endocrine (2,691), nutrition and blood (2,639), and

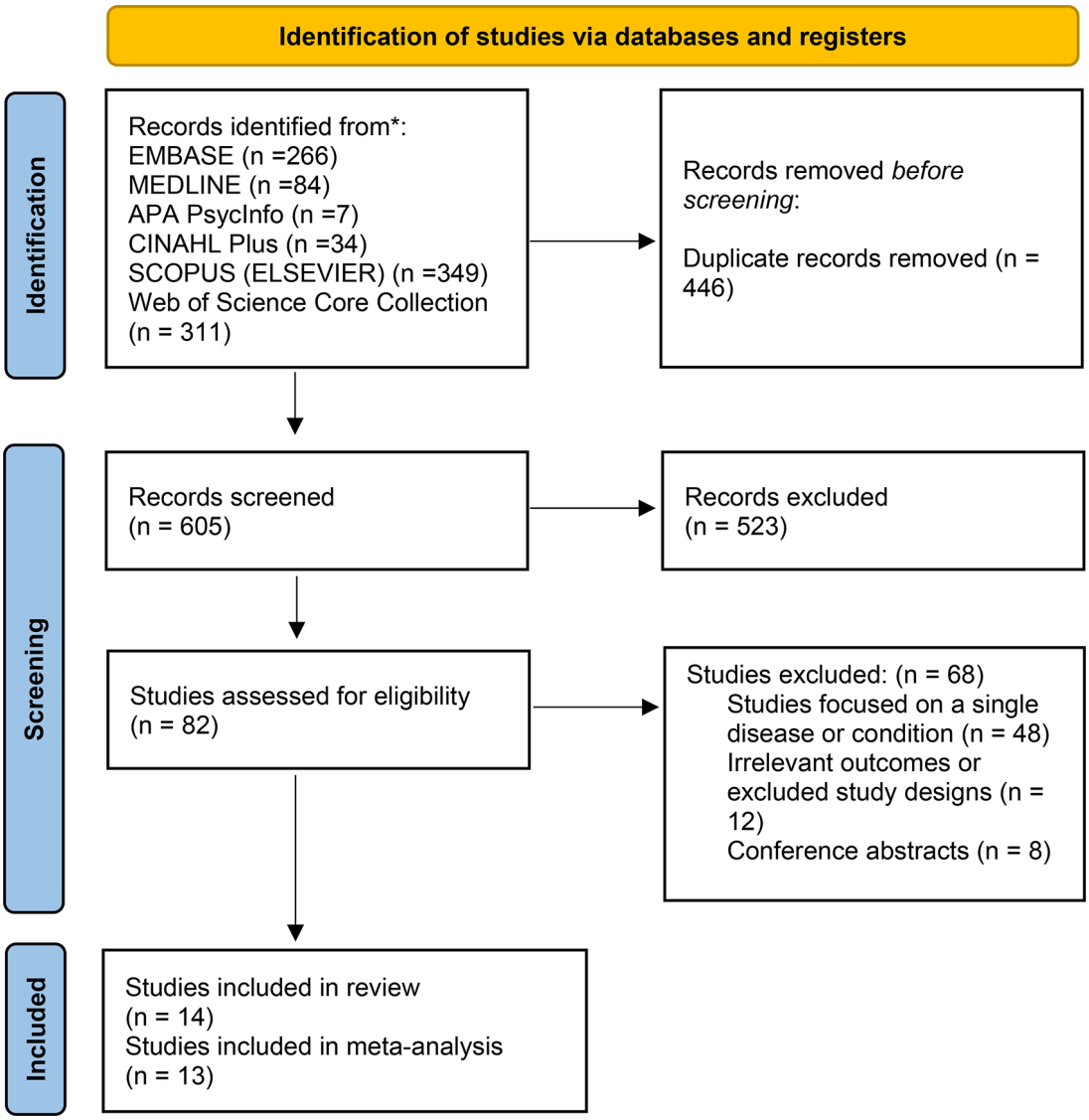

Fig. 1 PRISMA flow diagram

respiratory system medications (1,922) were less frequent (Figure S1).

3.3 Prevalence Findings

Overall, the synthesis of data from 13 studies revealed a median prevalence of PIP of 54.4% among older adults in GCC countries, with a range of 12.7–80.5% and an interquartile range (IQR) of 37.6–62.1% ($n = 18{,}647$). Hospital settings showed a higher median prevalence of PIP at 59.5% (IQR: 53.7–65.3%) compared to primary care settings, which had a median prevalence of 44.2% (IQR: 18.5–54.4%). Additionally, one study conducted in Qatar reported a PIP prevalence of 38% in a home care setting [Figure S2] [33]. In addition, only one study reported on Potential Prescribing Omissions (PPO) using the START criteria. This study found a prevalence of 19.8% [37].

3.4 Factors Associated with PIP Exposure

Polypharmacy was mentioned in nine of the included studies [27, 28, 30–32, 35, 37–40]. The reported prevalence of polypharmacy among the studies varied widely, ranging from 6.8 to 96.90% [27, 28, 30–32, 35, 37–40]. A total of five studies reported an association between polypharmacy and PIP use in the older patients [30, 32, 35, 37, 39]. This meta-analysis identified a strong association between polypharmacy and PIP exposure (OR: 5.26; 95% CI: 2.33–11.84). There was a high heterogeneity among meta-analysed studies ($I^2 = 98.7\%$) (Fig. 2).

Table 1 Characteristics of included studies

Study (author, year)	Study design	Setting	Data collection	Study period	Sample size	Age (Mean, years)	Number of medications mean (SD)	Prevalence of polypharmacy (%)	Tool	Number of PIP (or PPO)	Number of patients with at least one PIP (or (PPO)	PIP prevalence (or PPO)
Kuwait												
Alshammari et al. 2022 [35]	Retrospective cross-sectional	Hospital	Medical records	12 months	423	76	8.57 (5.20)	96.90%	Beers 2019	462	247	58.4%
Awad et al. 2019 [37]	Prospective cross-sectional	Primary care	Interviews and Medical records	9 months	420	73.1	6.3 (3.0)	72.10%	Beers 2015	365	223	53.1%
									STOPP version 2	351	234	55.7%
									START version 2*	136*	83*	19.8%*
									FORTA 2014	252	186	44.3%
									MAI	676	309	73.6%
Oman												
Al-Busaid et al. 2020 [29]	Retrospective cross-sectional	Primary care	Medical records	6 months	377	70.6	5 (3.5)	NR	Beers 2015	55	48	12.7%
									STOPP version 1	82	65	17.2%
Qatar												
Al-Dahshan et al. 2021 [30]	Retrospective cross-sectional	Primary Care	Medical records	6 months	5,639	72.8	NR	75.50%	Beers 2015	5713	4289	76.0%
Alhmoud et al. 2015 [33]	Retrospective cross-sectional	Home care	Medical records	3 months	501	79	10 (7.5)	NR	Beers 2012	255	191	38.2%
Alyazeedi et al. 2019 [40]	Retrospective cross-sectional	Hospital	Medical records	3 years	3,537	72.9	9.7 (4.2)	67.60%	Beers 2019	NR	2215	62.6%
Saudi Arabia												
Al Odhayani et al. 2017 [28]	NR	Hospital	Medical records	NR	798	75.2	1.45 (1.88)	6.8%	Beers 2012	568	419	52.5%
Alharbi et al. 2022 [31]	Retrospective cross-sectional	Hospital	Medical records	5 months and 20 days	1,123	71.90	6.06 (1.1)	34.90%	Beers 2019	744	NR	66.25%
Alhawassi et al. 2019 [32]	Retrospective cross-sectional	Hospital	Medical records	12 months	4,073	72.6	NR	80.50%	Beers 2015	3875	NR	PIM to avoid 57.6%. PIM to use with caution 37.5%
Al-Omar et al. 2013 [34]	Retrospective cross-sectional	Hospital	Prescription data	3 years	910,644 Prescriptions	74.02	NR	NR	Beers 2003	20,521	6045	2.3% of prescriptions
Alshehri et al. 2020 [36]	Retrospective cross-sectional	Hospital	Medical records	4 years	849	75.17	NR	NR	Beers 2019	1353	684	80.6%
Jastaniah et al. 2018 [38]	Retrospective cross-sectional	Hospital	Medical records	3 months	135	71.26	19 (10)	93.3%	Beers 2012	260	108	80.00%

Table 1 (continued)

Study (author, year)	Study design	Setting	Data collection	Study period	Sample size	Age (Mean, years)	Number of medications mean (SD)	Prevalence of polypharmacy (%)	Tool	Number of PIP (or PPO)	Number of patients with at least one PIP (or (PPO)	PIP prevalence (or PPO)
Alturki et al. 2020 [39]	Prospective cross-sectional	Hospital	Interviews and Medical records	12 months	270	72.41	4.09 (2.19)	55.20%	Beers 2015	164	164	60.7%
UAE												
Abdelwahed et al. 2021 [27]	Retrospective cross-sectional	Hospital	Medical records	3 Months	502	78.45	12.03 (4.8)	34.7%	Beers 2019	NR	174	34.7%.

PIP: Potentially inappropriate prescribing, PPO: Potential prescribing omissions, NR: Not reported, SD: Standard deviation

* Denotes potential prescribing omissions rather than inappropriate prescribing

Four studies examined the relationship between female gender and PIP exposure in older patients [27, 30, 37, 39]. The meta-analysis demonstrated a statistically significant 44% increased odds of PIP exposure among older females compared to males (OR: 1.44, 95% CI: 1.29–1.61). No heterogeneity was detected across these studies ($I^2 = 0.0\%$) (Fig. 3).

3.5 Subgroup Analyses

Subgroup analyses were conducted to evaluate the association between underlying chronic diseases and PIP exposure among older patients. Our meta-analysis revealed that older individuals with chronic conditions had a significant 38% increased odds of PIP exposure (OR: 1.38, 95% CI: 1.17–1.59, I2 = 87.9%). Specifically, higher odds of PIP exposure were observed in patients with diabetes (two studies; OR: 1.74, 95% CI: 1.18–2.30, I2 = 89.4), mental health disorders (two studies; OR: 1.39, 95% CI: 1.08–1.69, I2 = 0.0), and chronic kidney disease (CKD) (two studies; OR: 1.87, 95% CI: 1.19–2.54, I2 = 0.0). However, no significant associations were found for hypertension, cardiovascular disease, or dyslipidaemia. Further details are provided in Fig. 4.

3.6 Risk of Bias

The risk of bias varied among the included studies (Fig. 5). Most studies were rated completely with a "Yes" for the description of study subjects and settings, validity of measurements and appropriateness of statistical analysis. However, there were notable issues with sampling study participants appropriately (28.6% of included studies), sample frame appropriateness (14.3% of included studies) and sample size adequacy (14.3% of included studies), which all received "No" ratings in these areas. Additionally, a significant proportion of studies had unclear ratings for the reliability of the measurements and the adequateness of the sample size.

3.7 Publication Bias

Visual examination of the funnel plots revealed asymmetry, indicating potential publication bias (Figures S3, S4 and S5). However, Egger's regression test did not detect significant publication bias for studies reporting on polypharmacy (Egger's $p = 0.442$), female gender (Egger's $p = 0.108$), or chronic diseases (Egger's $p = 0.191$) in relation to PIM exposure.

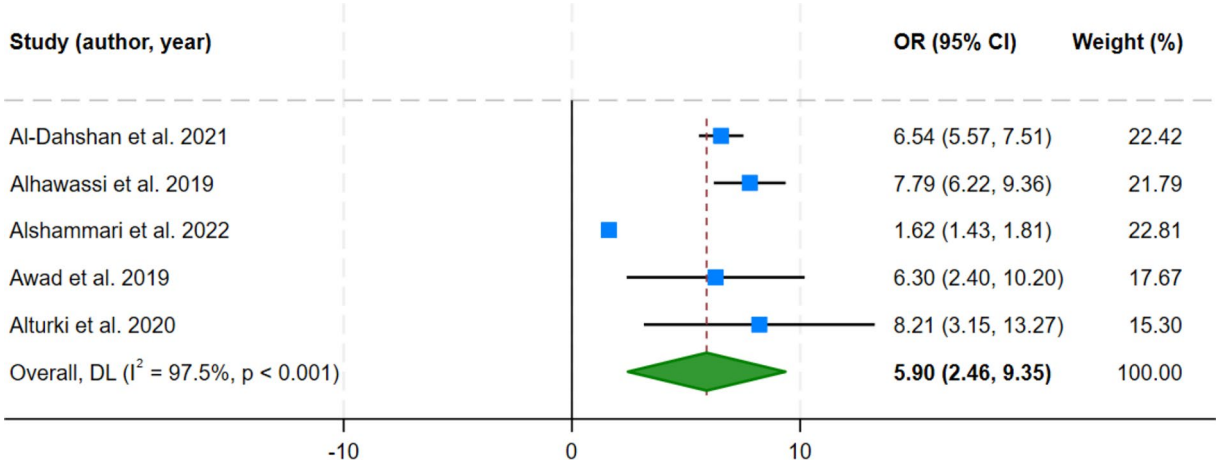

Fig. 2 Forest plot of odds ratios (OR) and 95% confidence intervals (CI) for the association between polypharmacy and potentially inappropriate prescribing exposure. *Note* Weights are from random-effects model

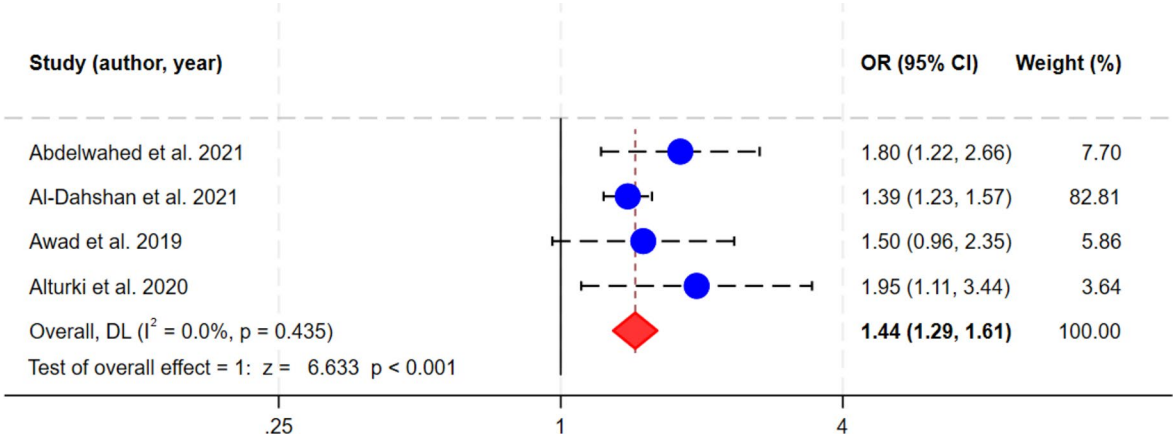

Fig. 3 Forest plot of odds ratios (OR) and 95% confidence intervals (CI) for the association between female gender and potentially inappropriate prescribing exposure. *Note* Weights are from random-effects model

4 Discussion

4.1 Summary of Main Findings

This systematic review and meta-analysis is the first to investigate the prevalence of PIP among older adults in the GCC region. The findings highlight a substantial overall prevalence of PIP, with higher median prevalence observed in hospital settings compared to primary care. Cardiovascular and gastrointestinal system medications were the most reported PIP, indicating critical areas for improvement in prescribing practices. Polypharmacy was significantly associated with PIP exposure. Additionally, female gender and chronic conditions were linked to increase odds of PIP exposure. Subgroup analyses showed that patients with diabetes, mental health disorders, and CKD had higher odds of PIP exposure. Our findings provide a comprehensive understanding of PIP patterns, aiming to inform policy and practice interventions to improve medication safety for older adults in the GCC countries.

4.2 Comparison with Existing Literature

Our findings align with existing literature employing similar inclusion and exclusion criteria in other regions. A systematic review analysing data from 26 studies in Central and Eastern Europe showed a PIP prevalence of 34.6% (IQR: 25.9–63.2%), lower than the median PIP prevalence in the GCC (54.4%; IQR: 37.6–62.1%) [15]. Our results also demonstrated a higher prevalence of PIP than reported in Europe (49%), North America (27%), and other countries (30%) [42]. A recent meta-analysis, including over five million individuals and 111 prevalence estimates, reported a global PIP prevalence of 33.3% in primary care setting [22]. Our study observed a higher PIP prevalence of 44.2% (IQR: 18.5–54.4%) in GCC primary care. This aligns with the higher PIP rates found in the UK, Australia, and New

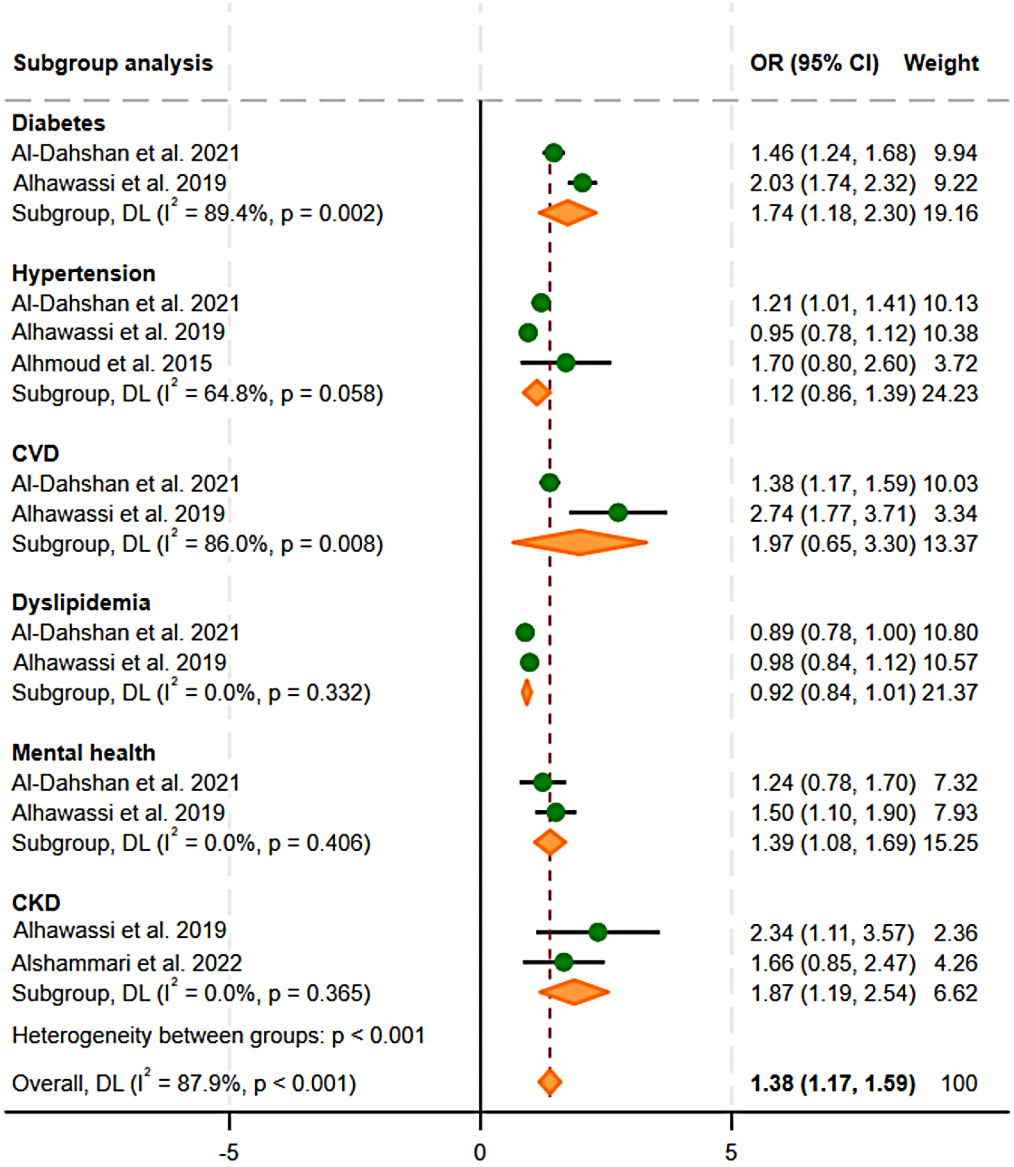

Fig. 4 Forest plot of subgroup analyses evaluating the association between underlying chronic diseases and potentially inappropriate prescribing exposure among older patients. *Note* Weights and between-subgroup heterogeneity test are from random-effects model

Zealand (35.9–59.2%) and contrasts with the lower rates in the US, Canada, and the Netherlands (23.2–29.9%) [22]. This considerable PIP prevalence highlights the need for targeted interventions to improve prescribing practices in the GCC.

The higher PIP prevalence in the GCC compared to the U.S. may be attributed to differences in healthcare infrastructure and practices The US healthcare system increasingly integrates clinical pharmacists into primary care teams, which may enhance medication management and reduce PIP rates [43]. In addition, Policies such as Medicare's push for medication therapy management (MTM) programs incentivize interventions targeting PIP [44, 45]. The widespread adoption of electronic health records (EHRs) and decision-support systems in the US helps flag PIP at the point of prescribing [43]. Besides, the US has long utilized explicit criteria for assessing PIP, such as the Beers Criteria, which are developed and maintained by the American Geriatrics Society and widely endorsed tool for PIP use in older adults. In contrast, these systems and practices are less universally implemented in the GCC, contributing to the observed differences.

Additionally, meta-analyses conducted in other regions have reported similar significant heterogeneity of PIP prevalence across countries and healthcare systems [16, 22]. This heterogeneity is reflected in our study, where differences based on the criteria used, data sources, and geographical areas within the GCC. Our findings also align with

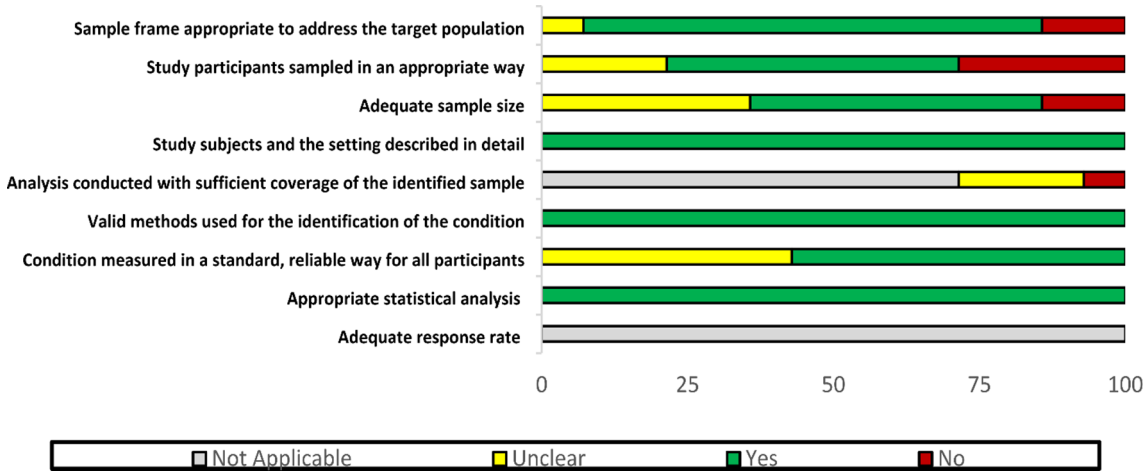

Fig. 5 Risk of bias: reviewers' judgements about each risk of bias item across all included studies. Presented as percentages

non-GCC studies regarding PIP associated factors, such as polypharmacy, comorbidities and gender [3, 20, 46]. These consistent findings highlight the importance of addressing polypharmacy and considering gender-specific strategies in interventions aimed at reducing PIP.

4.3 Strength and Limitations

This systematic review and meta-analysis have several strengths. A comprehensive search strategy and manual reference lists checking ensured thorough identification of all relevant studies, enhancing coverage. Including multiple GCC countries, provides a broader perspective on PIP prevalence among older adults in a region that shares common attributes [12]. Rigorous study selection and data extraction criteria enhance the reliability and validity. However, certain limitations exist. Non-English studies were excluded due to the limited availability of peer-reviewed research in local languages and the predominance of English-language publications in the GCC region. Additionally, studies focusing exclusively on specific drug classes or conditions were excluded, which may limit the applicability of our findings to these specific categories. Variations in pooled estimates between settings and PIP assessment criteria may impact generalizability. The reliance on retrospective cross-sectional designs and self-reported data in many studies pose additional limitations.

4.4 Implications for Practice

The high prevalence of PIP among older adults in the GCC countries highlights an urgent need for interventions from healthcare policymakers and practitioners to enhance medication safety and prescribing quality. Establishing standardized prescribing criteria, such as the Beers criteria and STOPP/START criteria, across all healthcare settings could play a critical role in reducing PIP risks. Integrating these criteria into routine medication review processes would allow healthcare providers to identify and address potentially harmful prescriptions systematically. To ensure the effectiveness of these measures, comprehensive training programs are essential for healthcare professionals. These programs should emphasize the appropriate use of PIP criteria, the value of regular medication reviews, and the management of polypharmacy and chronic conditions in older adults. Given our findings, gender-specific approaches may also be warranted, as older females appear at a higher risk for PIP, potentially benefiting from tailored strategies within medication-related services.

4.5 Future Research

Future research should focus on prospective longitudinal studies to assess the long-term impact of interventions aimed at reducing PIP. Studies exploring the cost-effectiveness of implementing standardized prescribing criteria and the role of pharmacists in managing PIP in older adults are warranted. Research should also aim to understand the cultural and systemic factors contributing to PIP in the GCC region to develop more effective, tailored interventions. Expanding research to include home care settings and primary care environments will provide a more comprehensive understanding of PIP across different healthcare contexts. In addition, as only one study reported PPO prevalence [37]. further research on PPO is needed to explore prescribing omissions systematically across diverse healthcare settings in the GCC.

5 Conclusion

This systematic review and meta-analysis sheds light on the prevalence and patterns of PIP among older adults in GCC countries. The high prevalence of PIP, particularly in hospital settings, highlights the need for further interventions to improve prescribing practices and medication safety for older adults. Polypharmacy and chronic conditions like diabetes, mental health disorders, and CKD were significantly associated with PIP exposure. These findings emphasize the importance of focusing on these groups to improve prescribing practices. Further research is needed, particularly in home care and primary care settings, to strengthen the evidence and enhance current practices.

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Author Contributions A.A.A. and W.Y.K. conceptualized and designed the study and were responsible for project administration and supervision. A.A.A. and W.Y.K. performed the literature search. S.M.A., R.M.A., R.M.A., M.S.A., and T.T.A. performed data screening and data synthesis. A.A.A., W.Y.K., S.M.A., R.M.A., R.M.A., M.S.A., and T.T.A. conducted the quality assessment and wrote the initial draft of the manuscript. A.B. performed the meta-analysis and contributed to substantial revisions of the manuscript. All authors reviewed and approved the final version of the manuscript.

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Data Availability No datasets were generated or analysed during the current study.

Declarations

Ethics Approval and Consent to Participate No needed.

Competing Interests The authors declare no competing interests.

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