© 2025 Journal of Pharmacy & Pharmacognosy Research, 13 (6), 1797-1818, 2025
ISSN 0719-4250
https://jppres.com

DOI: https://doi.org/10.56499/jppres25.2487_13.6.1797

Review

Explicit criteria for potentially inappropriate medications in older adults: A comprehensive systematic review

[Criterios explícitos para medicamentos potencialmente inapropiados en adultos mayores: Una revisión sistemática integral]

Eliezer Alemán-Fernández[1*], Dany Siverio-Mota[2], Liliana Vicet-Muro[2], Antonio J. Braza[3], Montserrat Viñas-Bastart[3], Pilar Modamio[3], René Delgado-Hernández[3,4]**

[1]Municipal Directorate of Pharmacy, Provincial Directorate of Public Health, Santa Clara, Villa Clara, Cuba.
[2]Department of Pharmacy. Central University of Las Villas. Villa Clara, Cuba.
[3]Clinical Pharmacy and Pharmaceutical Care Unit. Department of Pharmacy and Pharmaceutical Technology, and Physical Chemistry. Faculty of Pharmacy and Food Sciences. University of Barcelona. Av. Joan XXIII, 27-31, 08028 Barcelona, Spain.
[4]Institute of Pharmacy and Food. University of Havana. Havana, Cuba.
*E-mail: *eliezerfernandez1975@gmail.com, **renedelgado@ub.edu

Abstract

Context: Potentially inappropriate medications (PIMs) refer to the use of a medication whose risks outweigh the potential benefits in older adults, especially when other effective alternatives are available.

Aims: To identify and analyze explicit criteria developed for detecting PIMs in older adults, highlighting methodological approaches and pharmacological classifications.

Methods: A comprehensive literature search was conducted across seven databases from January 1990 to December 2024, following the PRISMA 2020 guidelines. Criteria developed using expert consensus or evidence-based processes were included.

Results: Out of 3,119 articles, 68 met the inclusion criteria. The Beers and STOPP/START tools were most frequently cited. The Delphi method was the predominant approach for validating the selected tools (73.53%). Commonly flagged medications included tricyclic antidepressants, NSAIDs, and benzodiazepines.

Conclusions: Numerous validated tools exist, although variations in validation methods and drug classification were observed. A global update and harmonization of explicit criteria are necessary for improved geriatric pharmacotherapy.

Keywords: Beers criteria; Delphi method; deprescribing tools; older adults; potentially inappropriate medications; STOPP START criteria.

Resumen

Contexto: La medicación potencialmente inapropiada (PIMs por sus siglas en inglés) se refiere al uso de un medicamento cuyos riesgos superan los beneficios potenciales en adultos mayores, especialmente cuando hay otras alternativas efectivas disponibles.

Objetivos: Identificar y analizar los criterios explícitos desarrollados para la detección de PIMs en adultos mayores, destacando los enfoques metodológicos y las clasificaciones farmacológicas.

Métodos: Se realizó una revisión sistemática exhaustiva utilizando siete bases de datos desde enero 1990 hasta diciembre 2024 siguiendo las directrices PRISMA 2020. Se incluyeron criterios desarrollados mediante consenso de expertos o procesos basados en la evidencia.

Resultados: De 3119 publicaciones, se incluyeron 68 herramientas. Los criterios de Beers y STOPP/START fueron los más citados. Para la validación de las herramientas seleccionadas predominó el método Delphi (73.53%). Los antidepresivos tricíclicos, NSAIDs y las benzodiazepinas fueron los medicamentos más señalados.

Conclusiones: Existen numerosas herramientas validadas, aunque fueron observadas variaciones en los métodos de validación y la clasificación de los medicamentos. Es necesaria una actualización y armonización global de los criterios explícitos para mejorar la farmacoterapia geriátrica.

Palabras Clave: adulto mayor; criterios de Beers; criterios STOPP START; herramientas de deprescripción; medicamentos potencialmente inapropiados; método Delphi.

ARTICLE INFO
Received: May 22, 2025.
Accepted: July 21, 2025.
Available Online: August 29, 2025.

AUTHOR INFO
ORCID: 0000-0002-6507-1761 (EAF) 0000-0002-8376-1088 (MVB)
0000-0003-3579-9783 (DSM) 0000-0003-3193-6285 (PM)
0000-0002-8682-0960 (LVM) 0000-0001-7051-7871 (RDH)
0009-0009-2669-7006 (AJB)

INTRODUCTION

According to the World Health Organization (WHO), aging populations are classified into stages: individuals aged 60–74 years are considered older adults, those between 75 and 90 years are categorized as elderly, and persons over 90 years are considered long-lived (Sánchez-Pérez et al., 2022). In 2019, the global population of individuals aged 60 years or older reached one billion and is projected to rise to 1.4 billion by 2030 and 2.1 billion by 2050 (World Health Organization, 2024).

In clinical practice, elderly individuals may be categorized as healthy, frail, or geriatric patients. Frailty refers to individuals who retain independence precariously and are at high risk of functional decline, while geriatric patients commonly present with complex, multifactorial conditions that are not always attributable to specific diseases (Antón-Jiménez et al., 2007). With increasing age, the prevalence of chronic diseases rises, leading to the frequent use of multiple medications.

Polypharmacy, often defined by the WHO as the concurrent use of five or more medications, is highly prevalent among older adults. More than half of adults over the age of 70 are prescribed three or more medications simultaneously (World Health Organization, 2020). This practice significantly elevates the risk of adverse drug events, drug–drug interactions, and therapeutic duplication, thereby compromising medication safety and treatment efficacy.

Unsafe medication practices and prescribing errors are among the leading causes of avoidable harm in healthcare systems globally. The WHO has estimated that medication-related harm accounts for over $42 billion in annual healthcare costs. In response, the WHO's third Global Patient Safety Challenge, "Medication without Harm," was launched to reduce avoidable medication-related harm by improving prescribing practices and enhancing awareness through tools such as the "Five Moments for Medication Safety" (World Health Organization, 2019).

A medication is considered potentially inappropriate (PIM) when its risks outweigh its expected benefits, particularly when safer alternatives exist (Amrouch et al., 2024). Two principal approaches exist to assess inappropriate prescribing: implicit and explicit criteria. Implicit methods rely on individualized clinical judgment and are resource-intensive, requiring trained personnel such as pharmacists. In contrast, explicit criteria are standardized tools, often based on expert consensus or evidence-based guidelines, and are more feasible for routine use during the prescribing process (Arroyave et al., 2023).

Prominent among the explicit tools are the Beers criteria, developed by the American Geriatrics Society, and the STOPP/START criteria, proposed by Gallagher et al. (2008) in Ireland and endorsed by the European Society of Geriatric Medicine. These tools have been widely adopted and adapted across various regions, taking into account local pharmacological formularies and prescribing practices.

Given the global expansion of the elderly population and the rising complexity of pharmacological care, a comprehensive synthesis of explicit PIM criteria is warranted. The objective of this systematic review was to identify and analyze existing explicit tools designed to detect potentially inappropriate medications in older adults and to evaluate their characteristics, methodological foundations, and clinical relevance.

MATERIAL AND METHODS

Study design

This comprehensive systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines and its extension for literature searches (PRISMA-S) to ensure methodological transparency and reporting quality (Page et al., 2021; Rethlefsen et al., 2021). The protocol was developed following the PRISMA-P 2015 framework (Shamseer et al., 2015) and was registered on June 18, 2025, in the International Prospective Register of Systematic Reviews (PROSPERO), under registration number CRD420251072494.

Search strategy

A structured literature search was performed to identify studies published between January 1, 1990, and December 31, 2024. The following databases were searched: MEDLINE (via PubMed), Virtual Health Library (BVS), ScienceDirect, Cochrane Library (CDSR), LILACS, IBECS, and SciELO. Controlled vocabulary terms (MeSH and DeCS) and free-text keywords related to potentially inappropriate medications were adapted for each database. The detailed search strategy is provided in Table 1.

Additionally, a manual search was conducted using Google Scholar, Semantic Scholar, and Research Gate to retrieve relevant gray literature and articles not indexed in the databases. Eligible studies in English or Spanish were considered if the full text or abstract was available in either language.

Table 1. Database-specific search strategies and number of studies retrieved (1990–2024).

Database	Searchstrategy	Studies(#)
MEDLINE (vía PubMed)	((Potentially inappropriate medication list*)OR (inappropriate prescribing*) OR (Inappropriate Medications*) [Mesh])	1428
VirtualHealthLibrary (BVS)	((Potentially inappropriate medication list*) OR (inappropriate prescribing*) OR (Inappropriate Medications*) [DeCS])	1280
ScienceDirect	((Potentially inappropriate medication list*) OR (inappropriate prescribing*) OR (Inappropriate Medications*) [DeCS])	94
CDSR	((Potentially inappropriate medication list*) OR (inappropriate prescribing*) OR (Inappropriate Medications*) [Mesh])	77
LILACS	((Potentially inappropriate medication list*) OR (inappropriate prescribing*) OR (Inappropriate Medications*) [DeCS])	63
IBECS	((Potentially inappropriate medication list*) OR (inappropriate prescribing*) OR (Inappropriate Medications*) [DeCS])	27
SCIELO	Potentially inappropriate medication list OR inappropriate prescribing OR Inappropriate Medications	16

Abbreviations: MEDLINE: National Library of Medicine's; BVS: Virtual Health Library; CDSR: Cochrane Database of Systematic Reviews; LILIACS: Latin American and Caribbean Health Sciences Literature; IBECS: Spanish Bibliographic Index in Health Sciences; SCIELO: Spanish Bibliographic Index of the Health Sciences and Scientific Electronic Library Online.

Inclusion and exclusion criteria

Studies were included if they described the development, validation, or adaptation of explicit criteria for identifying potentially inappropriate medications in older adults. Eligible tools were required to be developed for use in primary care settings and to have undergone expert consensus processes, guideline development methodologies, or evidence-based frameworks. Tools limited to specific disease categories or therapeutic groups were also included.

Studies were excluded if they lacked sufficient information on the tool's development, failed to specify the healthcare setting or patient population, or did not include a medication list. Observational studies evaluating inappropriate prescribing without presenting an explicit tool were also excluded.

Study selection

Two reviewers independently screened titles and abstracts for relevance. Full texts of potentially eligible studies were assessed against the inclusion and exclusion criteria. Discrepancies were resolved through discussion and consensus. Bibliographies of included studies were also examined (backward citation searching), and forward citation tracking was performed to identify additional relevant studies.

Data extraction

Data were extracted using a standardized form and included the following elements:

- Name of the explicit tool or criteria.
- Year and country of development.
- Geographic region.
- Study population and age range.
- Validation status and technique (e.g., Delphi, RAND/UCLA).
- Number and specialties of experts involved.
- Sources of literature used.
- Inclusion of drug–drug interactions, therapeutic alternatives, and pharmacological groups.
- Applicability by patient age or healthcare setting.

Synthesis and quality appraisal

A descriptive synthesis was carried out to compare tools based on their characteristics, validation methods, and pharmacological scope. The quality of evidence and strength of recommendations for each medication class were assessed in alignment with the American College of Physicians (ACP) framework and the Grading of Recommendations, Assessment, Development, and Evaluation (GRADE) approach (Balshem et al., 2011; Qaseem et al., 2010). These criteria evaluated risk of bias, consistency, directness, precision, and publication bias, as detailed in Table 2.

To assess the methodological quality of the included studies, we employed the AMSTAR 2 tool for systematic reviews and the ROBIS tool for risk of bias. Each study was independently appraised by two reviewers. Discrepancies were resolved through discussion. This step enabled us to classify the evidence base

Table 2. Grading of evidence quality and strength of recommendations based on ACP and GRADE frameworks.

Quality of evidence	ACP-based approach	GRADE-based approach
High	"Evidence…obtained from 1 or more well-designed and well-executed randomized, controlled trials (RCTs) that yield consistent and directly applicable results. This also means that further research is very unlikely to change our confidence in the estimate of effect."	Consider the following five factors for the studies that comprise the best-available evidence for a given criterion: 1. Risk of bias: Severity of threats to studies' internal validity (eg, randomized vs observational design, the potential for confounding, bias in measurement, etc.) 2. Inconsistency: Do different studies provide similar or different estimates of effect size? 3. Indirectness: How relevant are the studies to the clinical question at hand (eg, nature of the study of population, comparison group, type of outcomes measured, etc.)? 4. Imprecision: Precision of estimates of effect. 5. Publication bias: Risk of bias because of selective publication of results.
Moderate	"Evidence…obtained from RCTs with important limitations…. In addition, evidence from well-designed controlled trials without randomization, well-designed cohort or case–control analytic studies, and multiple time series with or without intervention are in this category. Moderate-quality evidence also means that further research will probably have an important effect on our confidence in the estimate of effect and may change the estimate."	
Low	"Evidence obtained from observational studies would typically be rated as low quality because of the risk for bias. Low-quality evidence means that further research is very likely to have an important effect on our confidence in the estimate of effect and will probably change the estimate. However, the quality of evidence may be rated as moderate or even high, depending on circumstances under which evidence is obtained from observational studies."	
Strength of recommendation		
Strong	Harms, adverse events, and risks clearly outweigh the benefits.	
Weak	Harms, adverse events, and risks may not outweigh the benefits.	

Abbreviations: ACP: American College of Physicians; GRADE: Recommendations Assessment, Development and Evaluation.

and consider the strength of recommendations and internal validity of each tool.

Justification for absence of meta-analysis

A meta-analysis was not conducted due to the descriptive and heterogeneous nature of the included studies. As the focus was on collecting and comparing explicit PIMs criteria rather than combining quantitative outcomes, a meta-analytic approach was neither appropriate nor feasible.

RESULTS

Study selection

The initial search yielded 3,119 potentially relevant publications, of which 2,985 were retrieved from electronic databases and 134 from other sources, including Google Scholar, Semantic Scholar, and ResearchGate. Following the removal of 1,217 duplicates, 1,774 observational studies were excluded, and six articles could not be retrieved. After applying the eligibility criteria, 122 full-text articles were assessed for inclusion. Of these, 54 were excluded due to irrelevance to the healthcare setting (n=22), absence of explicit medication lists (n=21), or incomplete data (n=11). A total of 68 studies were included in the final synthesis (Fig. 1, Table 3).

Characteristics of the included criteria

The included studies described 68 explicit tools for identifying potentially inappropriate medications (PIMs) in older adults. These tools were developed between 1994 and 2024, with the highest frequency observed in 2019 and 2023 (n=9, 13.24% each), followed by 2012, 2015, and 2016 (n=5, 7.35% each).

Geographically, most tools were developed in Europe (n=27, 39.71%), followed by Asia (n=14, 20.59%) and North America (n=12, 17.65%). Fewer tools were developed in Latin America (n=9, 13.24%), Oceania (n=5, 7.35%), and Africa (n=1, 1.47%), as reflected in Figs. 2 and 3.

Population characteristics

In the majority of studies (n=66, 97.06%), the target population's age was explicitly defined. The most common age threshold was ≥65 years (n=40, 58.82%), followed by ≥60 years (n=21, 30.88%). Only two studies included populations aged ≥75 years, and one study considered individuals ≥45 years. In two studies, the age was not specified (Table 4).

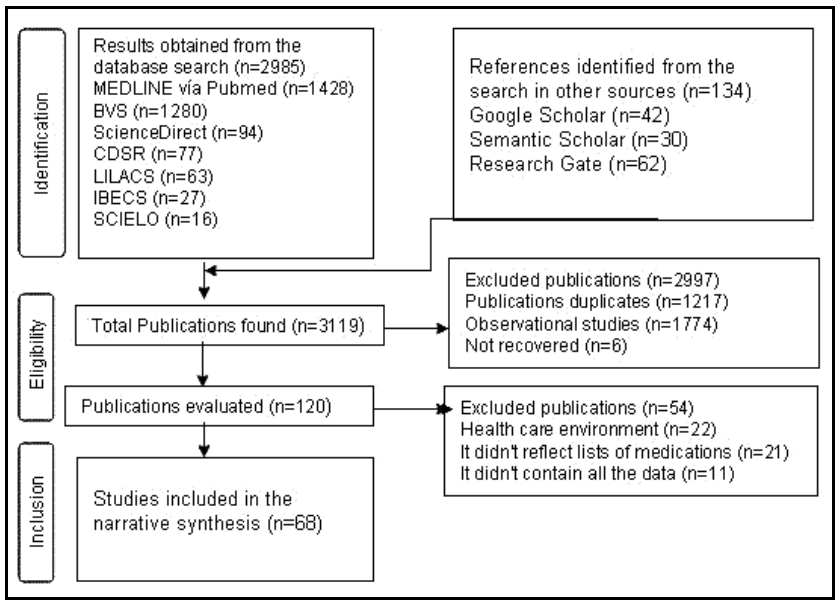

Figure 1. PRISMA 2020 flow diagram illustrating the study selection process for systematic review.

Abbreviations: MEDLINE: National Library of Medicine's; BVS: Virtual Health Library; CDSR: Cochrane Database of Systematic Reviews; LILIACS: Latin American and Caribbean Health Sciences Literature; IBECS: Spanish Bibliographic Index in Health Sciences; SCIELO: Spanish Bibliographic Index of the Health Sciences and Scientific Electronic Library Online.

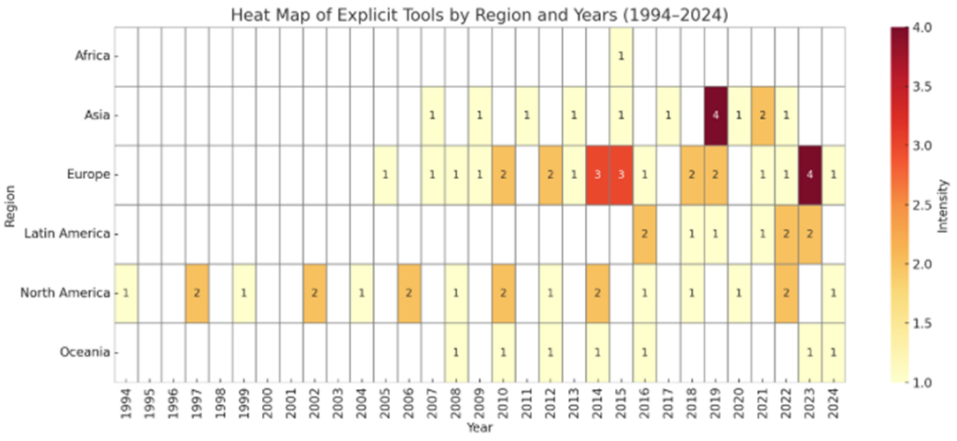

Figure 2. Heat map illustrating the frequency of studies performed using explicit tools by geographic region and year for the detection of Potentially Inappropriate Medications (PIMs) in older adults.

Validation techniques

Among the 68 tools, 58 (85.29%) were validated through formal processes, while 10 (14.71%) lacked documented validation. Of the validated tools, the Delphi method was the most frequently used, appearing in either modified (n=26, 38.24%) or standard forms (n=24, 35.29%). The predominance of two-round Delphi processes was noted across both forms. Other validation methods included evidence-based approaches (n=10, 14.71%), expert opinion (n=3, 4.41%), the RAND/UCLA method (n=3, 4.41%), nominal group technique (n=1, 1.47%), and the context validity index (n=1, 1.47%) (Table 5).

Expert participation and specialties

Twelve studies (17.65%) did not specify the number of participating experts. Among the remaining, the most common expert panel size ranged from 11 to 20 participants (n=26, 38.24%). Panels with ≥10 experts were used in 14 studies (20.59%), while seven studies included 21–30 experts (10.29%).

Table 3. Summary of explicit criteria by country, geographical area, validation technique, and expert panel size.

Name	Country	Geographical area	Validation technique	Experts (#)
Stuck criteria (Stuck et al., 1994)	United States-Canada	North America	Delphi Modified -2 rounds	13
McLeod criteria (McLeod et al., 1997)	Canada	North America	Delphi Modified -2 rounds	32
Lechevallier criteria (Lechevallier-Michel et al., 2005)	France	Europe	Experts' opinion	9
Pugh criteria (HEDIS) (Pugh et al., 2006)	United States	North America	Delphi Modified	No available
Lindblad criteria (Lindblad et al., 2006)	United States	North America	Delphi Modified -2 rounds	9
Laroche criteria (Laroche et al., 2007)	France	Europe	Delphi -2 rounds	15
Thailand's high-risk drug criteria (Winit-Watjana et al., 2008)	Thailand	Asia	Delphi-3 rounds	17 (1 and 2), 16 (3)
Maio criteria (Maio et al., 2010)	Italy	Europe	Nominal group technique	9
Matanovic criteria (Matanović and Vlahovic-Palcevski, 2012)	Croatia	Europe	Not validated	No available
Mann criteria (Mann et al., 2012)	Austria	Europe	Delphi Modified -2 rounds	8
Czech Republic criteria (Fialova et al., 2013)	Czech Republic	Europe	Delphi Modified -3 rounds	15
Prescribing Optimally in Middle-aged People's Treatments criteria (PROMPT) (Cooper et al., 2014)	Ireland	Europe	Delphi-2 rounds	17
List of High Risk Medications (Hanlon et al., 2015)	United States	North America	Not validated	3
European list (7)-PIM (Renom-Guiteras et al., 2015)	Europe	Europe	Delphi-2 rounds	26 (1) and24 (2)
Criteria for Patients with Dementia (MATCH-D) (Page et al., 2016)	Australia	Oceania	Delphi-3 rounds	55 (1), 48 (2) and 43 (3)
Passi criteria (Passi et al., 2016)	Chile	Latin America	Delphi	No available
Pakistan criteria (Mazhar et al., 2017)	Pakistan	Asia	Delphi-2 rounds	12
Argentina list (Marzi et al., 2018)	Argentina	Latin America	Delphi-2 rounds	10
Rognstad criteria (Rognstad et al., 2018)	Norway	Europe	Delphi Modified -3 rounds	57 (1), 50 (2) and 47 (3)
List of high-risk perioperative medications (Wang et al., 2019)	China	Asia	Delphi-2 rounds	36
Brazilian scale of drugs with anticholinergic activity (Nery and Reis, 2019)	Brazil	Latin America	Not validated	No available
Korean Anticholinergic Burden Scale (Jun et al., 2019)	Korea	Asia	Delphi Modified -2 rounds	7
Spanish List of Potentially Inappropriate Medicines (Project ES-PIAProject) (Gonzalez-Colaço Harmand et al., 2019)	Spain	Europe	Delphi-2 rounds	25

Table 3. Summary of explicit criteria by country, geographical area, validation technique, and expert panel size (continued...)

Name	Country	Geographical area	Validation technique	Experts (#)
Criteria for patients at risk of cardiovascular adverse events (Aguiar et al., 2019)	Portugal	Europe	Not validated	No available
Ortega-López criteria (Ortega López et al., 2021)	Cuba	Latin America	Delphi-2 rounds	11 (1) and 10 (2)
TIME 2020/ TIME 2021 criteria (Bahat et al., 2021)	Türkiye	Asia	Delphi-3 rounds	11
Hong Kong criteria (Zhang et al., 2021)	Hong Kong	Asia	Delphi Modified -2 rounds	8
Malaysian list (MALPIMS) (Chang et al., 2023)	Malaysia	Asia	Delphi-2 rounds	21
New Zealand criteria (Liu and Harrison et al., 2023)	New Zealand	Oceania	RAND/UCLA method -2 rounds	9
Medication-Related Falls Assessment and Scoring Tool (Saeed et al., 2024)	United Kingdom	Europe	Delphi-3 rounds	22
List of Australia (Wang et al., 2024)	Australia	Oceania	Delphi-2 rounds	33 (1) and 32 (2)
BEERS CRITERIA				
Version 2 (Beers, 1997)	United States	North America	Delphi Modified -2 rounds	6
Fick-Beers criteria (Version 3) (Fick et al., 2003)	United States	North America	Delphi Modified -3 rounds	12
Modified Beers criteria of Portugal (Soares et al., 2008)	Portugal	Europe	Not validated	No available
Version 4 (American Geriatrics Society Beers Criteria Update Expert Panel, 2012)	United States	North America	Delphi Modified -2 rounds	11
Version 4 in Spanish (Pastor Cano et al., 2015)	Spain	Europe	Not validated	No available
Version 5 (American Geriatrics Society Beers Criteria Update Expert Panel, 2015)	United States	North America	Delphi Modified -2 rounds	13
Version 6 (American Geriatrics Society Beers Criteria Update Expert Panel al., 2019)	United States	North America	Delphi Modified	13
Beers' criteria (Version 5) modified from Nigeria and South Africa (Saka et al., 2020)	Nigeria and South Africa	Africa	Delphi Modified -2 rounds	10
Beers' criteria (Version 5) modified from Argentina (Calabró et al., 2022)	Argentina	Latin America	Delphi Modified -2 rounds	38 (1) and 34 (2)
Version 7 (American Geriatrics Society Beers Criteria Update Expert Panel, 2023)	United States	North America	Delphi Modified -2 rounds	12
AUSTRALIAN INAPPROPRIATE PRESCRIBING CRITERIA				
Version 1 (Basger et al., 2008)	Australia	Oceania	Not validated	NA
Version 2 (Basger et al., 2012)	Australia	Oceania	RAND/UCLA method -2 rounds	15 (1) and 12 (2)

Table 3. Summary of explicit criteria by country, geographical area, validation technique, and expert panel size (continued...)

Name	Country	Geographical area	Validation technique	Experts (#)
STOPP-START CRITERIA				
Version 1 in Spanish (Delgado Silveira et al., 2009)	Spain	Europe	Indirect validation	No available
Rationalization of Home Medication by an Adjusted STOPP list in Older Patients (Lista RASP) (Van der Linden et al., 2014)	Belgium	Europe	Context validity index	19
Version 2 in Spanish (Delgado Silveira et al., 2015)	Spain	Europe	Indirect validation	No available
Japan STOPP criteria (STOPP-J) (Kojima et al., 2016)	Japan	Asia	Experts' opinion	No available
Modified US STOPP-START (Version 1) criteria (Khodyakov et al., 2017)	United States	North America	Delphi Modified -3 rounds	17 (1), 15 (2) and 11 (3)
Sri Lanka's modified STOPP-START criteria (Samaranayake et al., 2019)	Sri Lanka	Asia	Delphi-2 rounds	6
Modified Indonesian STOPP-START (Version 2) criteria (STOPP_INA) (Fauziyah et al., 2020)	Indonesia	Asia	Experts' opinion	8
Modified STOPP-START (Version 2) and Beers (Version 6) criteria from Colombia (Arroyave et al., 2023)	Colombia	Latin America	Delphi-2 rounds	5
Version 3 (O'Mahony et al., 2023)	Europe	Europe	Delphi-4 rounds	11
Version 3 in Spanish (Delgado-Silveira et al., 2023)	Spain	Europe	Indirect validation	No available
Version 3 in Spanish (Colombia, Argentina, and Spain) (De las Salas et al., 2023)	Colombia, Argentina, and Spain	Latin America-Europe	Delphi-2 rounds	16 (1) and 18 (2)
PRISCUS LIST				
Version 1 (Holt et al., 2010)	Germany	Europe	Delphi Modified -2 rounds	25 (1) and 26 (2)
Version 2 (Mann et al., 2023)	Germany-Austria	Europe	Delphi-3 rounds	59
KOREA CRITERIA				
Version 1 (Kim et al., 2010)	Korea	Asia	Delphi Modified -2 rounds	14
Version 3 (Kim et al., 2018)	Korea	Asia	Delphi Modified -4 rounds	14
TAIWAN CRITERIA				
Version 1 (Chang et al., 2012)	Taiwan	Asia	Delphi Modified -2 rounds	21
Version 2 (Chang et al., 2019)	Taiwan	Asia	Delphi Modified -2 rounds	24

Table 3. Summary of explicit criteria by country, geographical area, validation technique, and expert panel size (continued...)

Name	Country	Geographical area	Validation technique	Experts (#)
FORTA LIST				
Version 2 (Kuhn-Thiel et al., 2014)	Germany-Austria	Europe	Delphi-2 rounds	20
Version 4 (Pazan et al., 2022)	Germany-Austria-Switzerland	Europe	Delphi-2 rounds	20
BRAZILIAN CRITERIA				
Version 1 (Oliveira et al., 2016)	Brazil	Latin America	Delphi Modified -2 rounds	14
Version 2 (Pecce Bento et al., 2022)	Brazil	Latin America	Delphi Modified -2 rounds	18
GHEOP3S CRITERIA				
Version 1 (Tommelein et al., 2016)	Europe	Europe	RAND/UCLA method -2 rounds	12 (1) and 7 (2)
Version 2 (Foubert et al., 2021)	Belgium	Europe	Delphi Modified -2 rounds	15 (1) and 11 (2)
EURO-FORTA LIST				
Version 1 (Pazan et al., 2018)	Europe	Europe	Delphi-2 rounds	47
Version 2 (Pazan et al., 2023)	Europe	Europe	Delphi-2 rounds	32

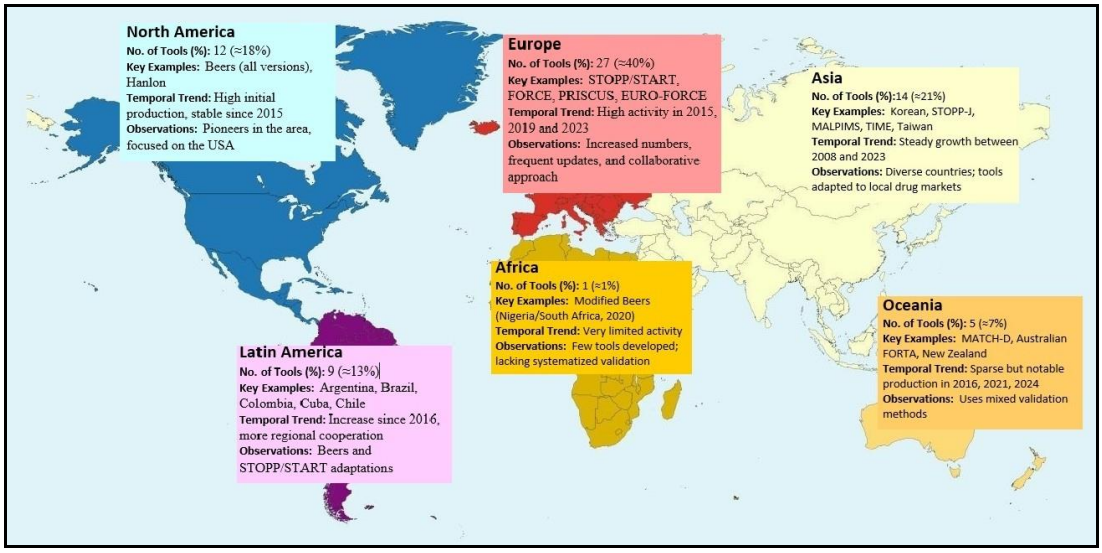

Figure 3. Regional distribution of studies carried out applying the explicit criteria for determining PIMs.

Table 4. Characteristics of included studies according to the target population age group

Target population	Number of studies	%
Not specified	2	2.94
≥ 45 years	1	1.47
≥ 60 years	21	30.88
≥ 65 years	40	58.82
≥ 70 years	2	2.94
≥ 75 years	2	2.94

Table 5. Validation techniques used in the development of explicit criteria for PIM identification.

Validation technique	Quantity of studies	%
Modified Delphi method	26	38.24
Delphi method	24	35.29
Evidence-based	10	14.71
Expert opinion	3	4.41
RAND/UCLA method	3	4.41
Nominal group technique	1	1.47
Context validity index	1	1.47

Geriatricians were the most commonly involved specialists (n=52, 76.47%), followed by pharmacists (n=39, 57.35%), pharmacologists (n=16, 23.53%), and general practitioners (n=14, 20.59%).

Evidence used in tool development

More than half of the tools (n=39, 57.35%) were based on the Beers criteria, followed by the STOPP/START criteria (n=28, 41.18%) and the PRISCUS list (n=11, 16.18%). Additionally, 24 tools (35.29%) were developed based on literature reviews and expert synthesis of available evidence.

Pharmacological groups identified

A wide range of pharmacological classes was cited across the reviewed criteria. Several drug groups appeared in more than 50% of the tools, with tricyclic antidepressants (TCAs) being the most frequently mentioned (n=65, 95.59%), followed by non-steroidal anti-inflammatory drugs (NSAIDs) and benzodiazepines (BZDs) (n=63 each, 92.65%).

Other commonly identified medications included:

- Aspirin and antipsychotics (n=58, 85.29%).
- Sulfonylureas (n=57, 83.82%).
- First-generation antihistamines (n=53, 77.94%).
- Immediate-release nifedipine (n=51, 75.00%).
- Opioids (n=50, 73.53%).
- Digoxin (n=49, 72.06%).
- Amiodarone (n=48, 70.59%).

The quality of evidence and strength of recommendations for each drug class were assessed. Most medications were supported by moderate to high-quality evidence and received strong recommendations for avoidance in older adults (Table 6).

Notably, 13 tools (19.12%) provided information on significant drug interactions, and 18 tools (26.47%) offered suggested therapeutic alternatives. Many tools emphasized medications with strong anticholinergic properties, particularly those associated with an increased risk of cognitive impairment and falls.

DISCUSSION

This systematic review highlights the extensive global development of explicit criteria to identify potentially inappropriate medications (PIMs) in older adults. The findings reflect the heightened awareness within the international scientific community regarding the risks associated with inappropriate prescribing in geriatric populations. The proliferation of tools, particularly in Europe, Asia, and North America, appears to correspond with the demographic shift toward aging populations in these regions.

Geographic disparities in the application of explicit criteria for identifying PIMs, such as the Beers Criteria and STOPP/START, underscore the influence of regional prescribing practices, healthcare policies, and drug availability on medication safety in older adults (American Geriatrics Society Beers Criteria Date Expert Panel, 2023; O'Mahony et al., 2023). While the Beers Criteria is widely adopted in the United States, its relevance in other regions may be limited due to differences in drug formularies, regulatory approvals, and clinical guidelines (American Geriatrics Society Beers Criteria Date Expert Panel, 2023; Anlay et al., 2024). For instance, some medications flagged in the Beers Criteria are rarely used in Europe or Asia. Conversely, STOPP/START, more commonly applied in Europe, includes drugs and omissions that reflect European prescribing trends and public health priorities. Low and middle-income countries face additional challenges, as limited access to alternatives and fragmented healthcare systems may render strict PIMs criteria impractical (Saka et al., 2020). Cultural attitudes toward aging and polypharmacy also play a role, while some regions may prioritize symptom control over deprescribing. Additionally, implementation barriers such as a lack of clinician awareness or reimbursement policies further widen disparities (Anlay et al., 2024).

Despite the abundance of explicit tools, their validation status and methodological robustness remain uneven. While most tools were validated using formal consensus methods, such as the Delphi technique, only a limited number employed standardized evidence-grading frameworks like GRADE (American Geriatrics Society Beers Criteria Date Expert Panel, 2023; Arroyave et al., 2023). The predominance of low-to-moderate quality evidence and variation in expert panel composition may contribute to inconsistencies in medication classification across tools, presenting potential barriers to their adoption in clinical practice.

The Delphi method has established itself as the predominant approach for validating explicit criteria to detect PIMs in older adults, primarily due to its ability to systematically synthesize expert consensus in areas where robust clinical evidence is lacking (Anlay et al., 2024; De las Salas et al., 2021). Unlike purely evidence-based methodologies, such as GRADE, which face limitations when applied to geriatric pharmacotherapy due to frequent data gaps, the Delphi technique's structured, iterative process of anonymous expert voting effectively minimizes individual biases while capturing collective clinical wisdom (Anlay et al., 2024; De las Salas et al., 2021).

This approach proves particularly valuable for PIM detection, where many critical decisions rely on observational data and practical experience rather than randomized controlled trials, as demonstrated by the widespread adoption of Delphi in developing regionspecific tools, such as STOPP/START and Asian PIM criteria (Chang et al., 2019; Kim et al., 2018; O'Mahony et al., 2023; Zhang et al., 2021). However, while Delphi excels in establishing face validity and clinical relevance, its reliance on expert opinion introduces inherent subjectivity, suggesting the need for complementary evidence-based validation when possible. The method's true strength lies in its adaptability, as it allows for the incorporation of local prescribing patterns and formularies while maintaining methodological rigor, making it uniquely suited for creating clinically actionable PIM criteria across diverse healthcare systems (Anlay et al., 2024; De las Salas et al., 2021).

Table 6. Frequently cited pharmacological groups in explicit criteria, with corresponding evidence level and recommendation strength.

Drugs	Number of studies	%	Quality of evidence	Strength of recommendation
Tricyclic antidepressants (TCAs)	65	95.59	High	Strong
Non-steroidal anti-inflammatory drugs (NSAIDs)	63	92.65	Moderate	Strong
Benzodiazepines (BZDs)	63	92.65	Moderate	Strong
Aspirin	58	85.29	High	Strong
Antipsychotics, first- (typical) and second- (atypical) generation	58	85.29	Moderate	Strong
Sulfonylureas	57	83.82	Hypoglycemia: High CV events and all causes mortality: Moderate CV death and ischemic stroke: Low	Strong
First-generation antihistamines	53	77.94	Moderate	Strong
Nifedipine, immediate release	51	75.00	High	Strong
Opioids	50	73.53	Moderate	Strong
Digoxin	49	72.06	Atrial fibrillation, heart failure: low dosage > 0.125 mg/day: moderate	Strong
Amiodarone	48	70.59	High	Strong
Central alpha-agonists	47	69.12	Low	Strong
Selective serotonin reuptake inhibitors	46	67.65	Moderate	Strong
Gastrointestinal antispasmodics with strong anticholinergic activity	43	63.24	Moderate	Strong
Non-selective peripheral alpha-1 blockers	41	60.29	Moderate	Strong
Antimuscarinics (urinary incontinence)	37	54.41	High	Strong
Skeletal muscle relaxants	36	52.94	Moderate	Strong

A striking observation is the limited adoption of GRADE beyond Beers (since 2012) and PRISCUS, with most tools relying on expert consensus (American Geriatrics Society Beers Criteria Date Expert Panel, 2023; Mann et al., 2023). While consensus methods capture clinical pragmatism, they risk subjectivity and variability in evidence interpretation, a challenge exemplified by the low overlap between PIM lists (Anlay et al., 2024; De las Salas et al., 2021). Hybrid models, such as PRISCUS's integration of GRADE with expert input, may offer a balanced solution, marrying methodological rigor with real-world applicability (Mann et al., 2023).

The Beers Criteria continue to serve as a foundational framework in the field of geriatric pharmacotherapy. Since their original publication in 1991, the criteria have undergone multiple revisions, with the most recent update in 2023 incorporating evidence quality and recommendation strength (American Geriatrics Society Beers Criteria Date Expert Panel, 2023). Despite their widespread use, the Beers criteria are limited by their applicability primarily to medications available in the United States. Nonetheless, they have influenced the development of regionally adapted lists in Latin America, Europe, and Africa (American Geriatrics Society Beers Criteria Update Expert Panel, 2023; Anlay et al., 2024).

The Beers Criteria, first introduced in 1991 by Dr. Mark Beers, were initially developed to identify PIMs for older adults in nursing homes, listing 40 high-risk drugs such as sedatives and anticholinergics (Beers et al., 1991). Over time, the criteria expanded beyond nursing homes to include all older adults and incorporated drug-disease interactions in the 1997 and 2003 updates (Beers,1997; Fick et al., 2003). A major shift occurred in 2012, when the American Geriatrics Society (AGS) adopted an evidence-based approach, systematically categorizing PIMs by drug class, dose limits, and interactions. Subsequent updates in 2015, 2019, and 2023 refined the list, adding newer risks while emphasizing deprescribing, frailty, and health equity (American Geriatrics Society Beers Criteria Update Expert Panel, 2012; 2015; 2019; 2023). The latest 2023 update integrates real-world data and digital decision support tools, reinforcing the need for individualized care rather than strict prohibitions (Fig. 4).

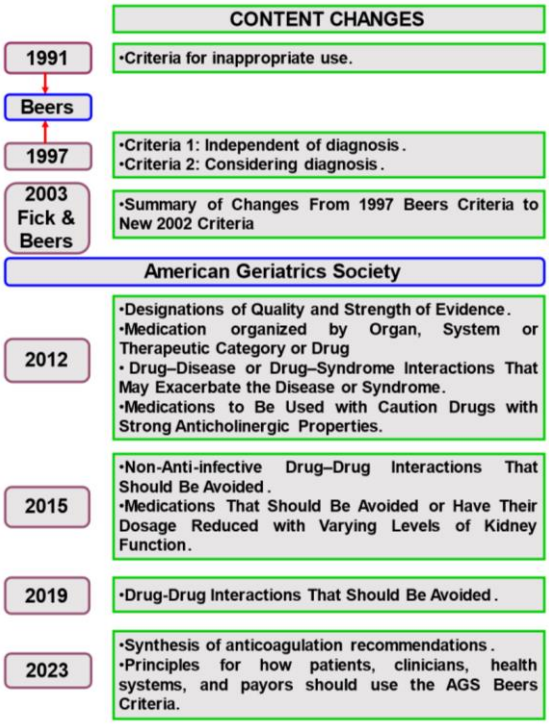

Figure 4. Evolutionary Diagram for Beer's Criteria.

The STOPP/START criteria, first introduced in 2008 as a more comprehensive alternative to the Beers Criteria, focus not only on inappropriate medications (STOPP) but also on potential prescribing omissions (START) in older adults. Unlike the Beers Criteria, which primarily flagged high-risk drugs, STOPP/START emphasized both underuse and overuse, promoting a more balanced approach to geriatric pharmacotherapy. The 2014 update refined the criteria with stronger evidence, adding new drug-disease interactions and expanding START to include evidence-based treatments (Delgado Silveira et al., 2009; 2015; 2023; O'Mahony et al., 2023).

The 2023 revision further enhanced clinical relevance by incorporating considerations of frailty, deprescribing guidance, and newer drug classes (Delgado-Silveira et al., 2023; O'Mahony et al., 2023). Unlike Beers, STOPP/START is organized by physiological systems, making it easier for clinicians to apply in practice. While both tools aim to reduce polypharmacy and adverse drug events, STOPP/START's dual focus on underprescribing and overprescribing has made it particularly valuable in European clinical guidelines and deprescribing initiatives (Delgado-Silveira et al., 2023; O'Mahony et al., 2023). The STOPP/START criteria are widely adopted, with several regional modifications identified (Arroyave et al., 2023; De las Salas et al., 2023; Fauziyah et al., 2020; Samaranayake et al., 2019). Their greater geographic applicability and recent Spanish-language adaptations enhance their utility in diverse healthcare settings (Fig. 5).

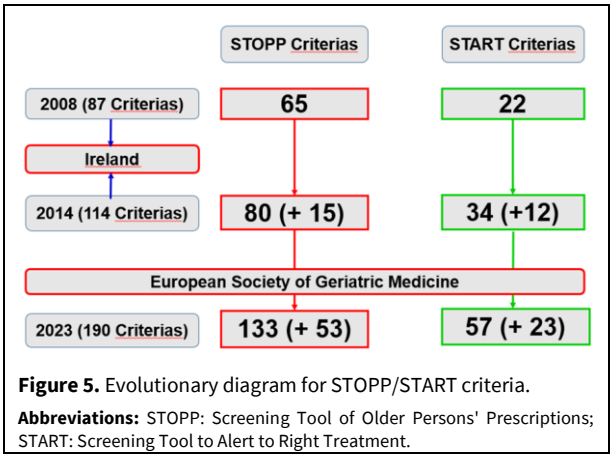

Figure 5. Evolutionary diagram for STOPP/START criteria.

Abbreviations: STOPP: Screening Tool of Older Persons' Prescriptions; START: Screening Tool to Alert to Right Treatment.

In Europe, several national and international tools have emerged, including the PRISCUS list, the European (7)-PIM list, and the FORTA system (Holt et al., 2010; Kuhn-Thiel et al., 2014; Mann et al., 2023; Oelke et al., 2015; Pazan et al., 2020a; 2020b; 2022; Renom-Guiteras et al., 2015; Wheling et al., 2017). These tools are tailored to medications commonly used in their respective regions and, in some cases, provide nuanced guidance based on therapeutic indications. The FORTA list, for example, has expanded to include specialized versions for specific drug classes, such as oral anticoagulants and medications for urinary tract symptoms.

In Asia, the criteria developed in Korea, Japan, Taiwan, and other countries demonstrate a growing commitment to optimizing geriatric pharmacotherapy (Chang et al., 2012; 2019; Kim et al., 2010; 2018; Kojima et al., 2016). The iterative refinement of these

tools, particularly Korea's four-stage Delphi updates, indicates a maturing approach toward incorporating national formulary relevance and clinical practice needs (Kim et al., 2018).

In Latin America, tools such as the Argentine and Brazilian PIM lists, as well as modified Beers and STOPP/START adaptations, signify increasing regional engagement (Arroyave et al., 2023; Calabró et al., 2022; Oliveira et al., 2016; Pecce-Bento et al., 2022). Cuba's Ortega criteria represent one of the most comprehensive Latin American efforts to contextualize explicit tools within a national healthcare system (Ortega López et al., 2021).

The landscape of tools for detecting PIMs reveals critical methodological and practical distinctions that influence their applicability across different settings (Anlay et al., 2024). The Beers criteria, with its drug-focused approach, contrasts sharply with STOPP/START, which adopts a condition framework that additionally identifies prescribing omissions (START), a feature absent in Beers (American Geriatrics Society Beers Criteria Date Expert Panel, 2023; O'Mahony et al., 2023). Notably, STOPP/START demonstrates superior sensitivity in European populations, likely due to its alignment with regional prescribing patterns and inclusion of clinical context beyond medication lists. Meanwhile, PRISCUS stands out for its innovative adaptation of the GRADE methodology to safety evaluations, particularly for high-risk subgroups such as patients with renal impairment or frailty, addressing a gap in conventional evidence appraisal for geriatric pharmacotherapy (Mann et al., 2023; O'Mahony et al., 2023).

Regional adaptations further highlight the importance of contextual relevance. The EU(7)-PIM list, while practical for pharmacists, suffers from infrequent updates, potentially limiting its alignment with contemporary evidence (Renom-Guiteras et al., 2015). Conversely, Asian PIMs criteria incorporate pharmacogenetic considerations, underscoring the necessity of tailoring tools to population-specific risks (Chang et al., 2012; 2019; Kim et al., 2010; 2018; Kojima et al., 2016). FORTA (A-D classification) offers a nuanced alternative to binary PIM lists by guiding clinicians toward personalized risk-benefit decisions, although its complexity may hinder widespread adoption (Pazan et al., 2022) (Table 7).

Among the included tools, only a few (e.g., the 2023 update of the Beers Criteria) explicitly used GRADE or similar evidence-grading frameworks. Most tools lacked transparent methodologies regarding how medications were selected and validated. AMSTAR 2 evaluations revealed moderate to low methodological quality in a significant proportion of the tools (American Geriatrics Society Beers Criteria Date Expert Panel, 2023).

A consistent pattern was observed in the pharmacological groups most frequently flagged as potentially inappropriate. TCAs, NSAIDs, and BZDs were among the most cited drug classes across nearly all tools (American Geriatrics Society Beers Criteria Date Expert Panel, 2023; De las Salas et al., 2021; O'Mahony et al., 2023). These medications are commonly associated with sedation, falls, gastrointestinal bleeding, and cognitive impairment, adverse outcomes particularly detrimental in older adults. Despite their inclusion in numerous explicit tools, these medications remain frequently prescribed, suggesting gaps in prescriber adherence or awareness.

Special attention has been directed toward medications with strong anticholinergic properties (American Geriatrics Society Beers Criteria Date Expert Panel, 2023; Jun et al., 2019; Nery and Reis, 2019; Ortega-López et al., 2021; Seppala et al., 2021). Their inclusion in explicit criteria underscores the importance of deprescribing efforts in older populations with cognitive vulnerability. Several tools, such as the Brazilian Anticholinergic Burden Scale and the Korean-specific anticholinergic criteria, have been designed to address this therapeutic challenge directly (Jun et al., 2019; Nery and Reis, 2019).

The incorporation of drug–drug and drug–disease interaction lists in more recent tools enhances clinical applicability (American Geriatrics Society Beers Criteria Date Expert Panel, 2023; Arroyave et al., 2023; Foubert et al., 2021; Ortega-López et al., 2021). However, these features remain insufficiently represented across the majority of tools and warrant more systematic inclusion in future updates.

The reliance on consensus-based methodologies, such as Delphi and RAND/UCLA techniques, reflects the complexities inherent in developing universal prescribing criteria for older adults (Basger et al., 2012; Liu and Harrison et al., 2023; Tommelein et al., 2016). While these methods facilitate structured expert agreement, they remain susceptible to bias related to panel composition, rating scales, and variability in local prescribing habits.

Policy and cultural considerations

The development and implementation of PIM tools are deeply influenced by national healthcare systems, regulatory environments, and cultural attitudes toward pharmacological interventions. Countries with centralized formularies or universal healthcare structures tend to facilitate broader adoption of such tools. Conversely, regions with limited research infrastructure or fragmented health systems,

Table 7. Comparison of PIMs detection criteria in older adults.

Criterion	Region	Development method	Key features	Strengths	Limitations	GRADE use
Beers (AGS)	USA	Expert consensus + systematic review	- Lists PIMs to avoid in older adults - Includes drug-disease interactions - Updated regularly	- Widely validated - Strong evidence base - Uses GRADE for evidence rating	- US-centric (some drugs not used in Europe) - Does not address under prescribing	Since 2012
STOPP/START	Europe (Ireland)	Expert consensus (Delphi method)	- STOPP Identifies PIMs START - Detects prescribing omissions - Organ-system approach	- Better at detecting PIMs than Beers in European studies - Covers underuse (START)	- Large number of criteria (190 in v3) - Time-consuming to apply	No (but evidence-based)
PRISCUS	Germany	Expert consensus + GRADE adaptation	- Focuses on high-risk PIMs in German elderly - Includes renal function adjustments	- Strong safety focus - Adapted GRADE for harm assessment	- Limited to German formulary - No under prescribing criteria	Modified GRADE
FORTA	Europe	Evidence-based + expert panel	- Classifies drugs as: A (essential) to D (avoid) - Individualized risk-benefit approach	- Validated in clinical trials (reduces ADRs) - Useful in multimorbidity	- Complex to apply - Less known outside Europe	In some studies
EU(7)-PIM	Europe (7 countries)	Derived from Beers, STOPP, PRISCUS	- Simplified list (282 PIMs) - Designed for pharmacists	- Harmonized European approach - Easy to apply in community settings	- Not updated since 2015 - No under prescribing criteria	No
Asian Criteria (e.g., Winit-Watjana)	Thailand /Asia	Local expert consensus	- Adapts Beers/STOPP to Asian drug availability and genetics	- Culturally relevant - Addresses regional polypharmacy trends	- Less validation outside Asia - Heterogeneous between countries	No

particularly in low- and middle-income countries, face challenges in developing or adapting explicit criteria (Anlay et al., 2024; De las Salas et al., 2021).

In addition, some countries prioritize certain classes of drugs differently due to cultural preferences or disease prevalence. This affects the inclusion or exclusion of specific drugs in regional lists. The variation in validation methods and quality grading among tools underlines the need for international consensus or adaptable frameworks that allow for regional customization without compromising methodological rigor (Anlay et al., 2024; De las Salas et al., 2021).

Limitations

Limitations of the selected PIM criteria

Overall, the most significant limitations during the validation process for the selected PIMs criteria included: Lack of validation of studies, especially in outpatient and/or clinical settings for older adults, inclusion of medications only available in the region, methodological heterogeneity, which complicates comparisons, clinical context is not taken into account: frailty, life expectancy, among others, and omission of insufficient prescription and alternatives.

Ultimately, the clinical utility of any explicit tool must be supported by its integration into local healthcare workflows and its adaptability to regional formularies. Explicit criteria are not intended to replace clinical judgment but rather to assist clinicians in evaluating therapeutic options critically. Therefore, adequate training and contextual application remain essential to optimize their effectiveness.

Other limitations

Several limitations should be acknowledged in this systematic review.

First, the literature search was restricted to articles published in English or Spanish. As a result, relevant tools and criteria published in other languages may have been omitted, which could potentially limit the comprehensiveness of the findings.

Second, access to certain databases, such as EMBASE, was not available, which may have led to the exclusion of studies indexed exclusively in subscription-based platforms. This limitation may have influenced the diversity and volume of retrieved tools.

Third, although an extensive number of tools were identified, many of them have not been regularly updated. Consequently, some tools may not reflect current clinical evidence or prescribing practices, thereby reducing their contemporary relevance.

Fourth, geographic representation was uneven. Very few tools were identified from Africa, highlighting an underrepresentation of criteria developed in low- and middle-income countries. This limits the global applicability of the findings and underscores the need for further research in underrepresented regions.

Fifth, while several tools included references to drug–drug and drug–disease interactions, this information remains insufficient across most criteria. Given the clinical importance of such interactions, their consistent integration into future PIM lists is recommended.

Sixth, a quality appraisal using AMSTAR 2 and ROBIS was applied retrospectively; however, limited reporting in the original studies affected the depth of evaluation.

Lastly, differences in healthcare policy, prescriber behavior, and pharmaceutical markets reduce the generalizability of some tools across countries.

Future directions

For future work, it is recommended to establish lines of research based on obtaining more information in the following aspects:

1. Develop a quantitative scoring system to objectively evaluate and compare tools, enabling standardized assessment across studies.

2. Conduct sensitivity analyses to assess the robustness of criteria frequently included in existing tools, ensuring their reliability and applicability.

3. Perform a meta-narrative synthesis to classify tools based on clinical setting or healthcare policy context, facilitating tailored tool selection for specific scenarios

CONCLUSION

This systematic review provides a comprehensive synthesis of explicit criteria developed globally to identify potentially inappropriate medications in older adults. The Beers and STOPP/START criteria remain the most widely adopted and influential tools, with numerous regional adaptations observed. A substantial number of criteria continue to highlight medications such as tricyclic antidepressants, nonsteroidal anti-inflammatory drugs, and benzodiazepines due to their strong association with adverse outcomes in the elderly.

Despite the diversity of tools identified, inconsistencies in validation methods, levels of evidence, and inclusion of clinically relevant interactions persist. These variations may limit the applicability of some tools across different healthcare settings. Furthermore, a lack of regular updates and limited representation from certain regions, particularly low- and middle-income countries, indicate important areas for improvement.

The findings underscore the need for the development and refinement of evidence-based, regularly updated, and regionally contextualized criteria to enhance medication safety in older adults. Explicit tools should serve as supportive instruments for clinical decision-making, complementing but not replacing professional judgment in geriatric pharmacotherapy.

The incorporation of evidence grading and broader geographic representation would strengthen future criteria development. Further research should focus on implementation and real-world impact to improve prescribing practices globally.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

ACKNOWLEDGMENTS

The authors would like to express sincere gratitude to Dr. Cecilia Fernández Lastra, Professor of Clinical Pharmacy and Pharmaceutical Care Unit, Faculty of Pharmacy and Food Sciences, University of Barcelona, for her invaluable contributions to the manuscript. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

REFERENCES

Aguiar JP, Brito AM, Martins AP, Leufkens HGM, da Costa FA (2019) Potentially inappropriate medications with risk of cardiovascular adverse events in the elderly: A systematic review of tools addressing inappropriate prescribing. J Clin Pharm Ther 44(3): 349–360. https://doi.org/10.1111/jcpt.12811

American Geriatrics Society Beers Criteria Update Expert Panel (2012) American Geriatrics Society updated beers criteria for potentially inappropriate medication use in older adults. J Am Geriatr Soc 60(4): 616–631. https://doi.org/10.1111/j.1532-5415.2012.03923.x

American Geriatrics Society Beers Criteria Update Expert Panel (2015) American Geriatrics Society 2015 updated Beers criteria for potentially inappropriate medication use in older adults. J Am Geriatr Soc 63(11): 2227–2246. https://doi.org/10.1111/jgs.13702

American Geriatrics Society Beers Criteria Update Expert Panel (2019) American Geriatrics Society 2019 updated AGS Beers Criteria for potentially inappropriate medication use in older adults. J Am Geriatr Soc 67(4): 674–694. https://doi.org/10.1111/jgs.15767

American Geriatrics Society Beers Criteria Update Expert Panel (2023) American Geriatrics Society 2023 updated AGS Beers Criteria for potentially inappropriate medication use in older adults. J Am Geriatr Soc 71(7): 2052–2081.https://doi.org/10.1111/jgs.18372

Amrouch C, Vauterin D, Amrouch S, Grymonprez M, Dai L, Damiano C, Calderón-Larrañaga A, Lahousse L, De Bacquer D, Lip GYH, Vetrano DL, De Smedt D, Petrovic M; AFFIRMO consortium (2024) Potentially inappropriate prescribing in multimorbid and polymedicated older adults with AF: A systematic review and meta-analysis. Drugs Aging 41(1): 13–30. https://doi.org/10.1007/s40266-023-01078-6

Anlay DZ, Paque K, Van Leeuwen E, Cohen J, Dilles T (2024) Tools and guidelines to assess the appropriateness of medication and aid deprescribing: An umbrella review. Br J Clin Pharmacol 90(1): 12–106. https://doi.org/10.1111/bcp.15906

Antón-Jiménez M, Abellán-Van Kan G, Sociedad Española de Geriatría y Gerontología (2007) Tratado de Geriatría para residentes. 1 ed. Sociedad Española de de Geriatría y Gerontología (SEGG).

Arroyave OL, Giraldo-Gallo EA, Segura-Cardona AM, Granados EJ (2023) Validation of explicit criteria for inappropriate prescription: STOPP/START and Beers for application in Colombia. Aten Prim Práct 5(3): 100179. https://doi.org/10.1016/j.appr.2023.100179

Bahat G, Ilhan B, Erdogan T, Merve-Oren M, Akif-Karan M, Burkhardt H, Denkinger M, Garfinkel D, Cruz-Jentoft AJ, Morrissey Y, Onder G, Pazan F, Tommelein E, Topinkova E, van der Velde N, Petrovic M (2021) International Validation of the Turkish Inappropriate Medication Use in the Elderly (TIME) Criteria Set: A Delphi Panel Study. Drugs Aging 38(6): 513–521. https://doi.org/10.1007/s40266-021-00855-5

Balshem H, Helfand M, Schunemann HJ, Oxman AD, Kunz R, Brozek J, Vist GE, Falck-Ytter Y, Meerpohl J, Norris S, Guyatt GH (2011) GRADE guidelines: 3. Rating the quality of evidence. J Clin Epidemiol 64(4): 401–406. https://doi.org/10.1016/j.jclinepi.2010.07.015

Basger BJ, Chen TF, Moles RJ (2008) Inappropriate medication use and prescribing indicators in elderly Australians: Development of a prescribing indicators tool. Drugs Aging 25(9): 777–793. https://dx.doi.org/10.2165/00002512-200825090-00004

Basger BJ, Chen TF, Moles RJ (2012) Validation of prescribing appropriateness criteria for older Australians using the RAND/UCLA appropriateness method. BMJ Open 2(5): e001431. https://doi.org/10.1136/bmjopen-2012-001431

Beers MH (1997) Explicit criteria for determining potentially inappropriate medication use by the elderly. An update. Arch Intern Med 157(14): 1531–1536. https://doi.org/10.1001/archinte.1997.00440350031003

Beers MH, Ouslander JG, Rollingher I, Reuben DB, Brooks J, Beck JC (1991) Explicit criteria for determining inappropriate medication use in nursing home residents. UCLA Division of Geriatric Medicine. Arch Intern Med 151(9): 1825–1832. https://doi.org/10.1001/archinte.1991.00400090107019

Calabró P, Donnianni I, Bellomo MJ, Mozeluk N, Elizondo C, Perman G, Schapira M, Giber F, TerrasaSA (2022) Beers criteria for identifying potentially inappropriate medication use: Adaptation for application in Argentina. Evid Actual Pract Ambul 25(4): e007032. https://doi.org/10.51987/evidencia.v26i1.7032

Chang CB, Lay HY, Hwang SJ, Yan SY, Wu RS, Chang LY, Lee IS, Liu HC, Chan DC (2019) The updated PIM-Taiwan criteria: A list of potentially inappropriate medications in older people. Ther Adv Chronic Dis 10: 2040622319879602. https://doi.org/10.1177/2040622319879602

Chang CB, Yang SY, Lai HY, Wu RS, Liu HC, Hsu HY, Hwang SJ, Chan DC (2012) Using published criteria to develop a list of potentially inappropriate medications for elderly patients in Taiwan. Pharmacoepidemiol Drug Saf 21(12): 1269–1279. https://doi.org/10.1002/pds.3274

Chang CT, Chan HK, Cheah WK, Tan MP, Ch'ng ASH, Thiam CN, Abu Bakar NA, Yau WK, Abu Hassan MR, Rajan P, Tan KC, Ambigapathy S, Vengadasalam P, Zaman Huri S, Arvinder-Singh HS, Thum CC, Chung WM, Ooi JH, Sabki NH, Lee HP, Mohd Shariff SM, Azman MA, Teoh SL, Lee SWH (2023) Development of a Malaysian potentially inappropriate prescribing screening tool in older adults (MALPIMS): A Delphi study. J Pharm Policy Pract 16(1): 122. https://doi.org/10.1186/s40545-023-00630-4

Cooper JA, Ryan C, Smith SM, Wallace E, Bennett K, Cahir C, Williams D, Teeling M, Fahey T, Hughes CM; (The PROMPT Steering Group) (2014) The development of the PROMPT (PRescribing Optimally in Middle-aged People's Treatments) criteria. BMC Health Serv Res 14: 484. https://doi.org/10.1186/s12913-014-0484-6

De las Salas R, Eslava-Schmalbach J, Vaca-González C, Machado M (2021) Tools and criteria for the prescription of inappropriate medication in older adults: A literature review with implications for patient care and clinical practice. Pharm Care Esp 23(2): 149–171.

De las Salas R, Vaca-González C, Eslava-Schmalbach J, Torres-Espinosa C, Figueras A (2023) Tackling potentially inappropriate prescriptions in older adults: Development of deprescribing criteria by consensus from experts in Colombia, Argentina, and Spain. BMC Geriatrics 23: 682. https://doi.org/10.1186/s12877-023-04271-9

Delgado-Silveira E, Molina-Mendoza MD, Montero-Errasquín B, Muñoz-García M, Rodríguez-Espeso EA, Vélez-Díaz-Pallarés M, Cruz-Jentoft AJ (2023) Spanish version of the STOPP/START 3 criteria: Advances in the detection of inappropriate prescribing medication in the older people. Rev Esp Geriatr Gerontol 58(5): 101407. https://doi.org/10.1016/j.regg.2023.101407

Delgado-Silveira E, Montero-Errasquín B, Muñoz-García M, Vélez-Díaz-Pallarés M, Lozano-Montoya I, Sánchez-Castellano C, Cruz-Jentoft AJ (2015) Improving drug prescribing in older people: A new edition of the STOPP-START criteria. Rev Esp Geriatr Gerontol 50(2): 89–96. https://doi.org/10.1016/j.regg.2014.10.005

Delgado-Silveira E, Muñoz-García M, Montero-Errasquín B, Sánchez-Castellano C, Gallagher PF, Cruz-Jentoft AJ (2009) Inappropriate drug prescribing in older patients: The STOPP-START criteria. Rev Esp Geriatr Gerontol 44(5): 273–279. https://doi.org/10.1016/j.regg.2009.03.017

Fauziyah S, Andrajati R, Dewi-Sartika RA, Radji M (2020) Adaptation and validation of the screening tool of older people's prescriptions instrument for the Indonesian

population. J Res Pharm Pract 9(1): 24–29. https://doi.org/10.4103/jrpp.JRPP_19_106

Fialova DT, Topinkova E, Ballokova A, Matejovska-Kubesova H (2013) 2012 CZ expert consensus for potentially inappropriate medication use in old age: appropriate choice of drugs and drug dosing in geriatric patients (section I), drug-disease interactions in the old age (Section II). Klin Farmakol Farmacie 27(1): 18–28.

Fick DM, Cooper JW, Wade WE, Waller JL, Maclean JR, Beers MH (2003) Updating the Beers criteria for potentially inappropriate medication use in older adults: results of a US consensus panel of experts. Arch Intern Med 163(22): 2716–2724. https://doi.org/10.1001/archinte.163.22.2716

Foubert K, Capiau A, Mehuys E, De Bolle L, Somers A, Petrovic M, Boussery K (2021) Ghent Older People's Prescriptions Community Pharmacy Screening (GheOP3S) Tool Version 2: Update of a Tool to Detect Drug Related Problems in Older People in Primary Care. Drugs Aging 38(6): 523–533. https://doi.org/10.1007/s40266-021-00862-6

Gallagher P, Ryan C, Byrne S, Kennedy J, O'Mahony D (2008) STOPP (Screening Tool of Older Person's Prescriptions) and START (Screening Tool to Alert doctors to Right Treatment). Consensus validation. Int J Clin Pharmacol Ther 46(2): 72–83. https://doi.org/10.5414/cpp46072

Gonzalez-Colaço-Harmand M, Aldea-Perona AM, Boada-Fernández-del Campo C, Areosa-Sastre A, Rodríguez-Jiménez C, García-Sánchez-Colomer M, Fernández Quintana E, Plasencia-Nuñez M, Masiero-Aparicio P, Grillo-Grillo C, Orellana-Mobilli A, García Sáiz M; ES-PIA project group, et al. (2019) Spanish list of potentially inappropriate drugs in the elderly (ES-PIA project). Eur J Clin Pharmacol 75(8): 1161–1176. https://doi.org/10.1007/s00228-019-02684-3

Hanlon JT, Semla TP, Schmader KE (2015) Alternative medications for medications in the use of high risk medications in the elderly and potentially harmful drug–disease interactions in the elderly quality measures. J Am Geriatr Soc 63(12): e8–e18. https://doi.org/10.1111/jgs.13807

Holt S, Schmiedl S, Thurmann PA (2010) Potentially inappropriate medications in the elderly: The PRISCUS list. Dtsch Arztebl Int 107(31–32): 543–551. https://doi.org/10.3238/arztebl.2010.0543

Jun K, Hwang S, Ah YM, Suh Y, Lee JY (2019) Development of an Anticholinergic Burden Scale specific for Korean older adults. Geriatr Gerontol Int 19(7): 628–634. https://doi.org/10.1111/ggi.13680

Khodyakov D, Ochoa A, Olivieri-Mui BL, Bouwmeester C, Zarowitz BJ, Patel M, Ching D, Briesacher B (2017) Screening tool of older person's prescriptions/screening tools to alert doctors to right treatment medication criteria modified for U.S. nursing home setting. J Am Geriatr Soc 65(3): 586–591. https://doi.org/10.1111/jgs.14689

Kim DS, Heo SI, Lee SH (2010) Development of a list of potentially inappropriate drugs for the Korean elderly using the Delphi method. Healthc Inf Res 16(4): 231–252. https://doi.org/10.4258/hir.2010.16.4.231

Kim MY, Etherton-Beer C, Kim CB, Yoon JL, Ga H, Kim HC, Song JS, Kim KI, Won CW (2018) Development of a consensus list of potentially inappropriate medications for Korean older adults. Ann Geriatr Med Res 22(3): 121–129. https://doi.org/10.4235/agmr.2018.22.3.121

Kojima T, Mizukami K, Tomita N, Arai H, Ohrui T, Eto M, Takeya Y, Isaka Y, Rakugi H, Sudo N, Arai H, Aoki H, Horie S, Ishii S, Iwasaki K, Takayama S, Suzuki Y, Matsui T, Mizokami F, Furuta K, Toba K, Akishita M; Working Group on Guidelines for Medical Treatment and its Safety in the Elderly (2016) Screening tool for older persons' appropriate prescriptions for Japanese: Report of the Japan Geriatrics Society Working Group on "Guidelines for medical treatment and its safety in the elderly". Geriatr Gerontol Int 16(9): 983–1001. https://doi.org/10.1111/ggi.12890

Kuhn-Thiel AM, Weiss C, Wehling M, Faep M (2014) Consensus validation of the FORTA (Fit fORThe Aged) List: a clinical tool for increasing the appropriateness of pharmacotherapy in the elderly. Drugs Aging 31(2): 131–140. https://doi.org/10.1007/s40266-013-0146-0

Laroche ML, Charmes JP, Merle L (2007) Potentially inappropriate medications in the elderly: A French consensus panel list. Eur J Clin Pharmacol 63(8): 725–731. https://doi.org/10.1007/s00228-007-0324-2

Lechevallier-Michel N, Gautier-Bertrand M, Alpérovitch A, Berr C, Belmin J, Legrain S, Saint-Jean O, Tavernier B, Dartigues JF, Fourrier-Réglat A; 3C Study group (2005) Frequency and risk factors of potentially inappropriate medication use in a community-dwelling elderly population: results from the 3C Study. Eur J Clin Pharmacol 60(11): 813–819. https://doi.org/10.1007/s00228-004-0851-z

Lindblad CI, Hanlon JT, Gross CR, Sloane RJ, Pieper CF, Hajjar ER, Ruby CM, Schmader KE (2006) Clinically important drug disease interactions and their prevalence in older adults. Clin Ther 28(8): 1133–1143. https://doi.org/10.1016/j.clinthera.2006.08.006

Liu L, Harrison BJ (2023) Development of explicit criteria identifying potentially inappropriate polypharmacy in older adults in New Zealand primary care: A mixed-methods study. J Prim Health Care 15(1): 38–47. https://doi.org/10.1071/HC22135

Maio V, Del Canale S, Abouzaid S, Investigators GAP (2010) Using explicit criteria to evaluate the quality of prescribing in elderly Italian outpatients: A cohort study. J Clin Pharm Ther 35(2): 219–229. https://doi.org/10.1111/j.1365-2710.2009.01094.x

Mann E, Bohmdorfer B, Fruhwald T, Roller-Wirnsberger RE, Dovjak P, Dückelmann-Hofer C, Fischer P, Rabady S, Iglseder B (2012) Potentially inappropriatemedication in geriatric patients: The Austrian consensus panel list. Wien Klin Wochenschr 124(5–6): 160–169. https://doi.org/10.1007/s00508-011-0061-5

Mann NK, Mathes T, Sönnichsen A, Pieper D, Klager E, Moussa M, Thürmann PA (2023) Potentially inadequate medications in the elderly: PRISCUS 2.0—first update of the PRISCUS list. Dtsch Arztebl Int 120(1–2): 3–10. https://doi.org/10.3238/arztebl.m2022.0377

Marzi MM, Pires MS, Quaglia NB (2018) Potentially Inappropriate Active Pharmaceutical Ingredients in Older Adults: IFAsPIAM List: Argentine Consensus Panel. Value Health Reg Issues 17: 38–55. https://doi.org/10.1016/j.vhri.2017.10.002

Matanović SM, Vlahovic-Palcevski V (2012) Potentially inappropriate medications in the elderly: a comprehensive protocol. Eur J Clin Pharmacol 68(8): 1123–1138. https://doi.org/10.1007/s00228-012-1238-1

Mazhar F, Akram S, Malhi SM, Haider N (2017) A prevalence study of potentially inappropriate medications use in hospitalized Pakistani elderly. Aging Clin Exp Res 30(1): 53–60. https://doi.org/10.1007/s40520-017-0742-7

McLeod PJ, Huang AR, Tamblyn RM, Gayton DC (1997) Defining inappropriate practices in prescribing for elderly people: A national consensus panel. Can Med Assoc J 156(3): 385–391. https://pmc.ncbi.nlm.nih.gov/articles/PMC1226961/

Nery RT, Reis AMM (2019) Development of a Brazilian anticholinergic activity drug scale. Einstein (Sao Paulo) 17(2): eAO4435. https://doi.org/10.31744/einstein_journal/2019AO4435

Oelke M, Becher K, Castro-Diaz D, Chartier-Kastler E, Kirby M, Wagg A, Wehling M (2015) Appropriateness of oral drugs for

long-term treatment of lower urinary tract symptoms in older persons: results of a systematic literature review and international consensus validation process (LUTS-FORTA 2014). Age Ageing 44(5): 745–755. https://doi.org/10.1093/ageing/afv077

Oliveira MG, Amorim WW, Oliveira CRB, Coqueiro HL, Gusmão LC, Passos LC (2016) Brazilian consensus on potentially inappropriate medications for the elderly. Geriatr Gerontol Aging 10(4): 168–181. https://doi.org/10.5327/Z2447-211520161600054

O'Mahony D, Cherubini A, Guiteras AR, Denkinger M, Beuscart JB, Onder G, Gudmundsson A, Cruz-Jentoft AJ, Knol W, Bahat G, van der Velde N, Petrovic M, Curtin D (2023) STOPP/START criteria for potentially inappropriate prescribing in older people: version 3. Eur Geriatr Med 14(4): 625–632. https://doi.org/10.1007/s41999-023-00777-y

Ortega-López IL, Couso-Seoane C, Dupotey-Varela NM, Reyes-Hernández I (2021) Criteria for potentially inappropriatemedication for the elderly: A Cuban proposal. MEDISAN 25(1): 95.

Page AT, Potter K, Clifford R, McLachlan AJ, Etherton-Beer C (2016) Medication appropriateness tool for co-morbid health conditions in dementia: Consensus recommendations from a multidisciplinary expert panel. Intern Med J 46(10): 1189–1197. https://doi.org/10.1111/imj.13215

Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, Shamseer L, Tetzlaff JM, Akl EA, Brennan SE, Chou R, Glanville J, Grimshaw JM, Hróbjartsson A, Lalu MM, Li T, Loder EW, Mayo-Wilson E, McDonald S, McGuinness LA, Stewart LA, Thomas J, Tricco AC, Welch VA, Whiting P, Moher D (2021) The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. PLoS Med 18(3): e1003583. https://doi.org/10.1371/journal.pmed.1003583

Passi A, Margozzini P, Valenzuela E, Hoyl T, Marin PP, Carrasco M, Olea R, Gac H (2016) Inappropriate medication use among Chilean older people. Rev Med Chil 144(4): 417–425. https://doi.org/10.4067/S0034-98872016000400001

Pastor Cano J, Aranda García A, Gascón Cánovas JJ, Rausell Rausell VJ, Tobaruela Soto M (2015) Spanish adaptation of the Beers criteria. An Sist Sanit Navar 38(3): 375–385.

Pazan F, Gercke Y, Weiss C, Wehling M, FORTA Raters (2020a) The U.S.-FORTA (Fit fOR The Aged) List: Consensus validation of a clinical tool to improve drug therapy in older adults. J Am Med Dir Assoc 21(3): 439.e9–439.e13. https://doi.org/10.1016/j.jamda.2019.07.023

Pazan F, Gercke Y, Weiss C, Wehling M, FORTA Raters (2020b) The JAPAN-FORTA (Fit fOR The Aged) list: Consensus validation of a clinical tool to improve drug therapy in older adults. Arch Gerontol Geriatr 91: 104217. https://doi.org/10.1016/j.archger.2020.104217

Pazan F, Weiss C, Wehling M (2018) The EURO-FORTA (Fit fOR The Aged) List International Consensus validation of a clinical tool for improved drug treatment in older people. Drugs Aging 35(1): 61–71. https://doi.org/10.1007/s40266-017-0514-2

Pazan F, Weiss C, Wehling M (2022) The FORTA (fit for the aged) list 2021: Fourth version of a validated clinical aid for improved pharmacotherapy in older adults. Drugs Aging 39(3): 245–247. https://doi.org/10.1007/s40266-022-00922-5

Pazan F, Weiss C, Wehling M, Forta Expert Panel Members (2023) The EURO-FORTA (Fit fOR The Aged) list version 2: Consensus validation of a clinical tool for improved pharmacotherapy in older adults. Drugs Aging 40(5): 417–426. https://doi.org/10.1007/s40266-023-01024-6

Pecce-Bento A, Costa-Pereira L, Ramos-Garcia K, Ramos-Ferreira LF, Vitória-da Silva E, Karnikowski M (2022) Inclusion of potentially inappropriate medicines for the older adults in the Brazilian consensus in accordance with international criteria. Clin Interv Aging 17: 151–161. https://doi.org/10.2147/CIA.S318578

Pugh MJ, Hanlon JT, Zeber JE, Bierman A, Cornell J, Berlowitz DR (2006) Assessing potentially inappropriate prescribing in the elderly Veterans Affairs population using the HEDIS 2006 quality measure. J Manag Care Pharm 12(7):537–545. https://doi.org/10.18553/jmcp.2006.12.7.537

Qaseem A, Snow V, Owens DK, Shekelle P (2010) Clinical Guidelines Committee of the American College of Physicians. The development of clinical practice guidelines and guidance statements of the American College of Physicians: Summary of methods. Ann Intern Med 153(3): 194–199. https://doi.org/10.7326/0003-4819-153-3-201008030-00010

Renom-Guiteras A, Meyer G, Thurmann PA (2015) The EU(7)-PIM list: A list of potentially inappropriate medications for older people consented by experts from seven European countries. Eur J Clin Pharmacol 71(7): 861–875. https://doi.org/10.1007/s00228-015-1860-9

Rethlefsen ML, Kirtley S, Waffenschmidt S, Ayala AP, Moher D, Page MJ, Koffel JB, PRISMA-S Group (2021) PRISMA-S: An extension to the PRISMA statement for reporting literature searches in systematic reviews. Syst Rev 10(1): 39. https://doi.org/10.1186/s13643-020-01542-z

Rognstad S, Brekke M, Gjelstad S, Straand J, Fetveit A (2018) Potentially Inappropriate prescribing to older patients: criteria, prevalence and an intervention to reduce it: the Prescription Peer Academic Detailing (Rx-PAD) study - a cluster-randomized, educational intervention in Norwegian general practice. Basic Clin Pharmacol Toxicol 123(4): 380–391. https://doi.org/10.1111/bcpt.13040

Saeed D, Carter G, Miller R, Darcy C, Miller K, Madden K, McKee H, Agnew J, Crawford P, Parsons C (2024) Development and Delphi consensus validation of the Medication Related Fall screening and scoring tool. Int J Clin Pharm 46(4): 977–986. https://doi.org/10.1007/s11096-024-01734-w

Saka SA, Oosthuizen F, Nlooto M (2020) Expert consensus on clinical applicability of the American Geriatrics Society-Beers Criteria to older persons in Africa: An exploratory validation study. J Eval Clin Pract 26(5): 1522–1529. https://doi.org/10.1111/jep.13339

Samaranayake NR, Balasuriya A, Fernando GH, Samaraweera D, Shanika LGT, Wanigasuriya JKP, Wijekoon CN, Wanigatunge CA (2019) Modified STOPP-START criteria for Sri Lanka; translating to a resource limited healthcare setting by Delphi consensus. BMC Geriatrics 19(1): 282. https://doi.org/10.1186/s12877-019-1293-x

Sánchez-Pérez H, Ramírez-Rosillo FJ, Carrillo-Esper R (2022) Polypharmacy in the elderly. Considerations in the preoperative period. Rev Mex Anestesiol 45(1): 40–47. Ahttps://doi.org/10.35366/102902

Seppala LJ, Petrovic M, Ryg J, Bahat G, Topinkova E, Szczerbinska K, van der Cammen TJM, Hartikainen S, Ilhan B, Landi F, Morrissey Y, Mair A, Gutiérrez-Valencia M, Emmelot-Vonk MH, Mora MÁC, Denkinger M, Crome P, Jackson SHD, Correa-Pérez A, Knol W, Soulis G, Gudmundsson A, Ziere G, Wehling M, O'Mahony D, Cherubini A, van der Velde N (2021) STOPPFall (Screening Tool of Older Persons Prescriptions in older adults with high fall risk): A Delphi study by the EuGMS Task and Finish Group on Fall-Risk-Increasing Drugs. Age Ageing 50(4): 1189–1199. https://doi.org/10.1093/ageing/afaa249

Shamseer L, Moher D, Clarke M, Ghersi D, Liberati A, Petticrew M, Shekelle P, Stewart LA; PRISMA-P Group (2015) Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015: Elaboration and explanation. BMJ 350: g7647. https://doi.org/10.1136/bmj.g7647

Soares MA, Fernandez-Llimós F, Lanca C, Cabrita J, Morais JA (2008) Operationalization to Portugal: Beers criteria of inappropriate medication use in the elderly. [Portuguese]. Acta Med Port 21(5): 441–452.

Stuck AE, Beers MH, Steiner A, Aronow HU, Rubenstein LZ, Beck JC (1994) Inappropriate medication use in community-residing older persons. Arch Intern Med 154(19): 2195–2200. https://doi.org/10.1001/archinte.1994.00420190095011

Tommelein E, Mehuys E, Petrovic M, Somers A, Van Damme C, Pattyn E, Mattelin K, Boussery K (2016) Potentially inappropriate prescribing in nursing home residents detected with the community pharmacist specific GheOP(3)S-tool. Int J Clin Pharm 38(5): 1063–1068. https://doi.org/10.1007/s11096-016-0366-6

Van der Linden L, Decoutere L, Flamaing J, Spriet I, Willems L, Milisen K, Boonen S, Tournoy J (2014) Development and validation of the RASP list (Rationalization of Home Medication by an Adjusted STOPP list in Older Patients): A novel tool in the management of geriatric polypharmacy. Eur Geriatr Med 5(3): 175–180. https://dx.doi.org/10.1016/j.eurger.2013.12.005

Wang K, Shen J, Jiang D, Xing X, Zhan S, Yan S (2019) Development of a list of high-risk perioperative medications for the elderly: a Delphi method. Expet Opin Drug Saf 18(9): 853–859. https://doi.org/10.1080/14740338.2019.1629416

Wang KN, Etherton-Beer CD, Sanfilippo F, Page AT (2024) Development of a list of Australian potentially inappropriate medicines using the Delphi technique. Int Med J 54(6): 980–1002. https://doi.org/10.1111/imj.16322

Wehling M, Collins R, Gil VM, Hanon O, Hardt R, Hoffmeister M, Monteiro P, Quinn TJ, Ropers D, Sergi G, Verheugt FWA (2017) Appropriateness of oral anticoagulants for the long-term treatment of atrial fibrillation in older people: results of an evidence- based review and international consensus validation process (OAC-FORTA 2016). Drugs Aging 34(7): 499–507. https://doi.org/10.1007/s40266-017-0466-6

Winit-Watjana W, Sakulrat P, Kespichayawattana J (2008) Criteria for high-risk medication use in Thai older patients. Arch Gerontol Geriatr 47(1): 35–51. https://doi.org/10.1016/j.archger.2007.06.006

World Health Organization (2019) Five moments for Medications Safety. https://www.who.int/initiatives/medication-without-harm [Consulted 10 May, 2025].

World Health Organization (2020) World Report on Aging and Health. Geneva: WHO. https://apps.who.int/iris/handle/10665/186463 [Consulted 27 February, 2025].

World Health Organization (2024) Home. Newsroom. Fact sheets. Detail. Ageing and health. https://www.who.int/es/news-room/fact-sheets/detail/ageing-and-health [Consulted 20 February, 2025].

Zhang H, Wong EL, Yeoh EK, Ma BH (2021) Development of an explicit tool assessing potentially inappropriate medication use in Hong Kong elder patients. BMC Geriatrics 21(1): 98. https://doi.org/10.1186/s12877-021-02024-0

AUTHOR CONTRIBUTION:

Contribution	Alemán E	Siverio D	Vicet L	Braza A	Viñas M	Modamio P	Delgado R
Concepts or ideas	x	x					
Design	x						
Definition of intellectual content	x						
Literature search	x	x					
Data acquisition	x						
Data analysis	x						
Statistical analysis	x						
Manuscript preparation	x	x					
Manuscript editing	x	x	x	x	x	x	x
Manuscript review	x	x	x	x	x	x	x

Citation Format: Alemán E, Siverio D, Vicet L, Braza A, Viñas M, Modamio P, Delgado R (2025) Explicit criteria for potentially inappropriate medications in older adults: A comprehensive systematic review. J Pharm Pharmacogn Res 13(6): 1797–1818. https://doi.org/10.56499/jppres25.2487_13.6.1797

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Annex 1. PRISMA 2020 checklist.

Section and Topic	Item #	Checklist item	Location where item is reported
TITLE			
Title	1	Identify the report as a systematic review.	1
ABSTRACT			
Abstract	2	See the PRISMA 2020 for Abstracts checklist.	1-2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of existing knowledge.	2
Objectives	4	Provide an explicit statement of the objective(s) or question(s) the review addresses.	2
METHODS			
Eligibility criteria	5	Specify the inclusion and exclusion criteria for the review and how studies were grouped for the syntheses.	3
Information sources	6	Specify all databases, registers, websites, organisations, reference lists and other sources searched or consulted to identify studies. Specify the date when each source was last searched or consulted.	2
Search strategy	7	Present the full search strategies for all databases, registers and websites, including any filters and limits used.	3
Selection process	8	Specify the methods used to decide whether a study met the inclusion criteria of the review, including how many reviewers screened each record and each report retrieved, whether they worked independently, and if applicable, details of automation tools used in the process.	3
Data collection process	9	Specify the methods used to collect data from reports, including how many reviewers collected data from each report, whether they worked independently, any processes for obtaining or confirming data from study investigators, and if applicable, details of automation tools used in the process.	3
Data items	10a	List and define all outcomes for which data were sought. Specify whether all results that were compatible with each outcome domain in each study were sought (e.g. for all measures, time points, analyses), and if not, the methods used to decide which results to collect.	No
	10b	List and define all other variables for which data were sought (e.g. participant and intervention characteristics, funding sources). Describe any assumptions made about any missing or unclear information.	No
Study risk of bias assessment	11	Specify the methods used to assess risk of bias in the included studies, including details of the tool(s) used, how many reviewers assessed each study and whether they worked independently, and if applicable, details of automation tools used in the process.	3-4
Effect measures	12	Specify for each outcome the effect measure(s) (e.g. risk ratio, mean difference) used in the synthesis or presentation of results.	NA
Synthesis methods	13a	Describe the processes used to decide which studies were eligible for each synthesis (e.g. tabulating the study intervention characteristics and comparing against the planned groups for each synthesis (item #5)).	NA
	13b	Describe any methods required to prepare the data for presentation or synthesis, such as handling of missing summary statistics, or data conversions.	NA
	13c	Describe any methods used to tabulate or visually display results of individual studies and syntheses.	NA
	13d	Describe any methods used to synthesize results and provide a rationale for the choice(s). If meta-analysis was performed, describe the model(s), method(s) to identify the presence and extent of statistical heterogeneity, and software package(s) used.	3-4
	13e	Describe any methods used to explore possible causes of heterogeneity among study results (e.g. subgroup analysis, meta-regression).	NA
	13f	Describe any sensitivity analyses conducted to assess robustness of the synthesized results.	3
Reporting bias assessment	14	Describe any methods used to assess risk of bias due to missing results in a synthesis (arising from reporting biases).	3
Certainty assessment	15	Describe any methods used to assess certainty (or confidence) in the body of evidence for an outcome.	NA

Annex 1. PRISMA 2020 checklist (continued...)

Section and Topic	Item #	Checklist item	Location where item is reported
RESULTS			
Study selection	16a	Describe the results of the search and selection process, from the number of records identified in the search to the number of studies included in the review, ideally using a flow diagram.	4-5
	16b	Cite studies that might appear to meet the inclusion criteria, but which were excluded, and explain why they were excluded.	No
Study characteristics	17	Cite each included study and present its characteristics.	6-11
Risk of bias in studies	18	Present assessments of risk of bias for each included study.	NA
Results of individual studies	19	For all outcomes, present, for each study: (a) summary statistics for each group (where appropriate) and (b) an effect estimates and its precision (e.g. confidence/credible interval), ideally using structured tables or plots.	NA
Results of syntheses	20a	For each synthesis, briefly summarize the characteristics and risk of bias among contributing studies.	NA
	20b	Present results of all statistical syntheses conducted. If meta-analysis was done, present for each the summary estimate and its precision (e.g. confidence/credible interval) and measures of statistical heterogeneity. If comparing groups, describe the direction of the effect.	NA
	20c	Present results of all investigations of possible causes of heterogeneity among study results.	NA
	20d	Present results of all sensitivity analyses conducted to assess the robustness of the synthesized results.	NA
Reporting biases	21	Present assessments of risk of bias due to missing results (arising from reporting biases) for each synthesis assessed.	No
Certainty of evidence	22	Present assessments of certainty (or confidence) in the body of evidence for each outcome assessed.	12
DISCUSSION			
Discussion	23a	Provide a general interpretation of the results in the context of other evidence.	11-15
	23b	Discuss any limitations of the evidence included in the review.	15
	23c	Discuss any limitations of the review processes used.	15-16
	23d	Discuss implications of the results for practice, policy, and future research.	16
OTHER INFORMATION			
Registration and protocol	24a	Provide registration information for the review, including register name and registration number, or state that the review was not registered.	2
	24b	Indicate where the review protocol can be accessed, or state that a protocol was not prepared.	2
	24c	Describe and explain any amendments to information provided at registration or in the protocol.	No
Support	25	Describe sources of financial or non-financial support for the review, and the role of the funders or sponsors in the review.	16
Competing interests	26	Declare any competing interests of review authors.	16
Availability of data, code and other materials	27	Report which of the following are publicly available and where they can be found: template data collection forms; data extracted from included studies; data used for all analyses; analytic code; any other materials used in the review.	No

Legend: NA: not applicable.

Source: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al (2021) The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. PLoS Med 18(3):e1003583. DOI: 10.1371/journal.pmed.1003583