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Intervention Elements to Reduce Inappropriate Prescribing for Older Adults with Multimorbidity Receiving Outpatient Care: A Scoping Review

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ABSTRACT

Objective: Polypharmacy occurs in approximately 30% of older adults aged 65 years or more, particularly among those with multimorbidity. With polypharmacy, there is an associated risk of potentially inappropriate prescribing (PIP). The aims of this scoping review were to (i) identify the intervention elements that have been adopted to reduce PIP in the outpatient setting and (ii) determine the Behaviour Change Wheel intervention functions performed by each of the identified intervention elements.

Design: Scoping Review

Data sources: PubMed, CINAHL, EMBASE, Web of Science and Cochrane Library databases, grey literature sources, six key geriatrics journals and the reference lists of review papers.

Study selection: All studies reporting an intervention or strategy that addressed PIP in the older adult population (age ≥65) with multimorbidity in the outpatient setting and in which the primary prescriber is the physician.

Data extraction: Data extracted from the included studies can be broadly categorized into (i) publication details (ii) intervention details and (iii) results. This was followed by data synthesis and analysis based on the Behaviour Change Wheel (BCW) framework[1].

Results: Of 8204 studies yielded, 80 studies were included in the final analysis and 14 intervention elements were identified. An average of two to three elements was adopted in each intervention. The three most used intervention elements were medication review (70%), training (26.3%) and tool/instrument(s) (22.5%). Among medication reviews, 60% involved pharmacists. The 14 intervention elements were mapped onto five intervention functions: "*education*", "*persuasion*", "*training*", "*environmental restructuring"* and "*enablement"*.

Conclusion: PIP is a multi-faceted problem that involves multiple stakeholders. Interventions to address PIP have multiple elements targeting the behaviour of different stakeholders. The intervention elements and their corresponding functions identified in this scoping review will inform the design of complex interventions that aim to reduce PIP.

Keywords: aged; geriatrics; polypharmacy; ambulatory care; behaviour change wheel; intervention components

ARTICLE SUMMARY

Strength and limitations of this study:

- This is the first attempt to map the extent and nature of information on this topic in both peer-reviewed and grey literature.
- This study aimed to achieve methodological rigor by adhering closely to the scoping review framework outlined by Arksey & O'Malley[2] and applying the recommendations proposed by Levac *et al.*[3] and JBI[4].
- An appropriate theoretical framework was used to synthesize and analyze the data.
- The results from this review can be used to guide the design of complex interventions to reduce PIP among older adults.
- Consultation with experts and stakeholders was initiated at the time of writing and will be reported in a separate work.

INTRODUCTION

Polypharmacy, commonly defined as the use of five or more medications daily, is an increasingly prevalent phenomenon among older adults as they tend to develop multiple chronic diseases or multimorbidity with age[5]. A longitudinal, cohort study of over 2,000 community-dwelling older adults of aged 62 to 85 years in the US showed that the prevalence of polypharmacy increased from 30.6% to 35.8% between 2005 and 2011[6]. Similar trends have also been observed in other developed countries, such as UK, Netherlands and Belgium[7–9]. Polypharmacy is a cause for concern as it predisposes older adults to potentially inappropriate prescribing (PIP), which occurs when medicines prescribed confer more harm than benefit[10]. Current clinical guidelines are designed to be disease-specific, and many do not take into consideration drug-disease and drug-drug interactions in their treatment recommendations[11,12]. In older adults, adverse side effects are made even more unpredictable by age-related changes in pharmacokinetics and pharmacodynamics[13,14]. This problem is further exacerbated by the fact that clinical trials often exclude older adults, which means approved drug doses may not be appropriate for geriatric patients[15].

It is estimated that up to 50% of older adults receive at least one unnecessary medication, and the incidence of PIP increases significantly with polypharmacy[16,17]. Older adults with at least 2 PIP indicators based on the Screening Tool of Older Person's Potentially Inappropriate Prescriptions (STOPP) criteria were shown to be twice as likely to experience adverse drug events (ADEs)[18]. Apart from drug-related problems, older adults with PIP also reported poorer functional status, reduced health-related quality of life and increased health care utilization, including more frequent emergency department visits and hospitalizations[19–21]. Given the high prevalence of PIP and its adverse outcomes, it is therefore imperative for appropriate measures to be implemented to improve prescribing for older adults. With rising concern on suboptimal prescribing both internationally and at home, a three-phase implementation research project aiming to reduce PIP among older adults is underway. The first phase includes a literature review to examine interventions to reduce PIP among older adults with multimorbidity receiving outpatient care. While there have been several systematic reviews performed to explore interventions that address PIP, these reviews often include a limited number of studies as they only looked at either specific study types (e.g., randomized controlled trials[22]) or specific intervention types (e.g., computerized decision support systems[23] and pharmacist-led medication reviews[24]). Moreover, systematic reviews often restrict inclusion to studies that fulfill a certain standard of methodological rigour and reporting, which could result in the omission of a significant number of potentially relevant studies[25].

In addition, reviews of complex interventions can be challenging as there is currently no formal methodology for the synthesis of data from these studies[26]. There is also great variability among complex interventions in terms of their components and modes of delivery, which makes it even harder to perform comparative analyses[26]. To overcome this problem, a theoretical framework could be applied to organize and make sense of the data extracted. In this scoping review, the Behaviour Change Wheel (BCW) framework[1] was used. The BCW was developed by Michie and colleagues (2011) as a framework to systematically guide development of interventions using theory. In the BCW framework, evidence-based principles of behavior change are represented in the core model of behavior: capability, opportunity, motivation and behavior (COM-B)[27]. COM-B identifies sources of behavior that could bring about a change, which are mapped to nine intervention functions: *education*, *persuasion*, *incentivisation*, *coercion*, *training*, *restriction*, *environmental restructuring*, *modeling* and *enablement*. This approach offers a systematic method

of characterizing and analyzing intervention content. As such, in order to capture the breadth of intervention studies that have been conducted to address PIP, we adopted a scoping review methodology to identify all relevant information irrespective of study type and quality of their sources.

The aims of our scoping review were thus to: (i) identify intervention elements and within-element variations that have been adopted to reduce inappropriate prescribing among older adults in the outpatient setting and (ii) map the intervention elements to the BCW intervention functions for synthesis. The findings will contribute to the knowledge base to inform development of a collaborative care intervention to reduce PIP which will be tested in subsequent study phases. To our knowledge, there are no scoping reviews published that map information on the extent and nature of care interventions to reduce PIP from both peer-reviewed and grey literature.

METHODS

The methodological framework developed by Arksey and O'Malley[2] was adopted, with application of recommendations proposed by Levac *et al.*[3] and the Joanna Briggs Institute (JBI)[4]. Five of the six stages outlined in the framework were performed: (i) identifying the research question; (ii) identifying relevant studies; (iii) selecting studies; (iv) charting data and (v) summarizing and reporting the results.

Identifying the research question

This scoping review was guided by the research question: "What intervention elements have been adopted to reduce inappropriate prescribing among older adults with multimorbidity in outpatient care?" The research question was formulated after several rounds of discussion within the study team (one physician (YYD), two pharmacists (KTT and WA) and three researchers (KY, JQL, PL). Following recommendation by JBI[4], the research question incorporated the elements "Population, Concept and Context".

Identifying the relevant studies

We started with five articles that are relevant to our research question and identified the keywords and MeSH terms that were used to describe these articles. These search terms were then categorized into "Population", "Concept" and "Context" and additional keywords and MeSH terms were identified through searching their synonyms and the MeSH browser respectively. The final list of search terms can be found in Supplementary File 1.

We conducted a pilot search in Ovid MEDLINE. Using the five articles as a test of sensitivity and specificity, the search strategy was refined after several iterative searches. The eventual search strategy was then adapted for the remaining databases using the appropriate syntax. The following six electronic databases were searched on 28 January 2019: (i) PubMed; (ii) CINAHL (EBSCOHost); (iii) Web of Science; (iv) Embase (Ovid); (v) The Cochrane Library and (vi) Scopus. Our searches were limited to English Language only with publication date from January 1998 to the date performed (January 2019). The full electronic search strategy for PubMED is provided in Supplementary File 2.

We also performed a search for grey literature in February 2019 in 13 resources, including ClinicalTrials.gov (https://clinicaltrials.gov/), OpenGrey (http://www.opengrey.eu/), Science.gov (https://www.science.gov/) and WorldCat (https://www.worldcat.org/). In addition, six key geriatrics and gerontology journals were searched electronically: (i) Journal of the American Geriatrics Society; (ii) Age and Ageing; (iii) The Journals of Gerontology Series A; (iv) Archives of Gerontology and Geriatrics (v) BMC Geriatrics and (vi) European Geriatric Medicine. Various combinations of the following keywords were used: 'intervention' and 'inappropriate prescribing', combined with 'multimorbidity', 'comorbidity' and 'polypharmacy'. Where possible, language and publication date limits were imposed (as above).

Screening and study selection procedures

The eligibility criteria were developed based on the research question and further refined along the way as the reviewers become more familiar with the evidence base. Our inclusion criteria were: (i) original publications that describe an intervention or strategy that addresses PIP in a population that includes older adults (age ≥ 65 years); (ii) intervention was carried out in the outpatient setting; (iii) physicians were the prescribers and (iv) prescribing was not restricted to specific disease or

condition(s) e.g., hypertension, chronic obstructive pulmonary disease or specific medication(s) e.g., opioids.

The screening was conducted in Covidence® and consisted of two stages. The first stage involved title and abstract screening, which was performed independently by two reviewers (KY and JQL). Reviewers met at the beginning, midpoint and final stages of the abstract review process to clarify doubts and establish a common understanding of the inclusion criteria, as recommended by Levac *et al.*[3]. In the second stage, the same reviewers again reviewed the full text articles independently, before meeting to discuss and resolve conflicts. A third reviewer (YYD) was involved in resolving conflicts whenever necessary. During the screening process, systematic reviews that were relevant to the research question were also identified and their reference lists were searched to garner additional primary studies for inclusion. The systematic review papers were not included in data extraction and synthesis.

Charting the data

A data charting form was developed and used to extract data from the included studies. The extracted information included: (i) publication details: author(s), year of publication, country of origin; (ii) intervention details: study type, participants, description of intervention and (iii) results: outcome measures. Charting of the first three studies was performed together by the two reviewers (KY and JQL) to establish a standardized method of extraction. The reviewers then each charted half of the remaining studies.

Collating, summarizing and reporting of results

The first step of data synthesis involved identifying the intervention elements present in each study. During full text screening of 80 articles, a provisional list of common intervention elements implemented in the reported studies was identified by the reviewers (e.g., medication reviews, education and training, case conference, medication reconciliation, etc.) and the list was extended and refined along the way. Coding of the intervention elements was performed independently by the two reviewers (KY and JQL), before meeting to compare, discuss and reach a consensus on the coding.

Application of Behaviour Change Framework

The intervention elements were then mapped to the BCW intervention functions: *education*, *persuasion*, *incentivisation*, *coercion*, *training*, *restriction*, *environmental restructuring*, *modeling* and *enablement.* The definitions and examples of the BCW intervention functions are outlined in Supplementary File 3. Two reviewers (KY and JQL) performed the mapping independently before discussing and finalizing the synthesis.

RESULTS

Study selection and characteristics of included studies

The review selection process is summarized in Figure 1 using a PRISMA flow diagram. The initial search yielded 8204 abstracts after removal of duplicates. After title and abstract screening and full text review, 71 studies were included. Eleven systematic review papers relevant to our research question were identified and searched based on their reference lists, adding another 9 studies. A total of 80 studies were included for data extraction and synthesis (references to the included studies are provided in Supplementary File 4). They comprised 40 interventional studies, 13 observational studies, 13 study protocols, 13 conference abstracts and 1 report. The characteristics of the included studies are summarized in Table 1. The studies originated from 19 countries, with the majority from the United States (n = 25, 32%). More than 60% of the included studies were published in the last five years i.e. 2014 to present.

Table 1. Characteristics of included studies

Characteristic	Frequency Count	Percentage
Study Type		
Interventional Studies	40	50.0%
Randomized Controlled Trial	17	21.3%
Pre-post study	9	11.3%
Cluster Randomized Controlled Trial	7	8.8%
Non-randomized trial	6	7.5%
Randomized Trial	1	1.3%
Observational Studies	13	16.3%
Prospective Cohort Study	10	12.5%
Retrospective Cohort Study	2	2.5%
Cross-sectional study	1	1.3%
Others	27	33.8%
Study Protocol	13	16.3%

Conference Abstract	13	16.3%
Report	1	1.3%
Publication Year		
1998 - 2003	8	10.0%
2004 - 2008	8	10.0%
2009 - 2013	15	18.8%
2014 - 2019	49	61.3%
Country of Origin		
US & Canada	31	38.8%
UK & Ireland	5	6.3%
Scandinavia	9	11.3%
Western Europe	25	31.3%
Asia	6	7.5%
Australia	3	3.8%
Others	1	1.3%

Intervention elements identified

Included studies identified 14 intervention elements. Within each intervention element, variations were noted and coded separately to capture the differences in which the elements were performed (e.g., medication review performed by pharmacist or physician or both physician and pharmacist). The definitions of the 14 intervention elements are outlined in Tables 2, 3 and 4. *Medication review* was found to be the most frequently adopted intervention element (n=56; 70%), followed by *Training* (n=21; 26.3%), *Tool/instrument(s)* (n=18; 22.5%), *Feedback & audit* (n=15; 18.8%) and *Medication therapy management* (n=14; 17.5%). Of all medication reviews, 70% involved pharmacists (n=39; MR1, 2, 3 and 4), 27% were performed by physicians alone (n=15; MR5) and 2.5% performed by physicians and medical assistants (n=2; MR6). *Case conference* and *Peer support* were the least frequently adopted intervention elements (n=3 and n=2 respectively). Interventions have an average of 2.5 elements, with more than 80% (n=65) consisting of more than one element. The highest number of elements present in a single intervention is eight[28].

Mapping of intervention elements to BCW intervention functions

The 14 intervention elements were mapped to five of the nine BCW intervention functions, namely *education, persuasion, training, environmental restructuring* and *enablement.* Tables 2, 3 and 4 summarize the 14 intervention elements and their corresponding intervention functions. There were no intervention elements that map to the other 4 intervention functions (*Incentivisation,*

Coercion, Restriction, Modelling)[1]. *Environmental restructuring* and *enablement* were the two functions that were most commonly present in the intervention elements (n = 11 and n = 16 out of 24).

Medication review

Pharmacist-led medication reviews (MR1), medication reviews conducted by an external team of pharmacist(s) and/or physician(s) (MR3) and medication reviews conducted by pharmacist(s) without communicating recommendations to the physician directly (MR4) all contained the same three functions. Firstly, *persuasion* is the function identified, when a pharmacist's recommendations were communicated to the physicians, thus prompting them to reconsider their prescription for the respective patients. *Environmental restructuring* is also present, since involving the pharmacist changes the social context of the physician[1]. The third function is *enablement,* where the physicians' means to prescribe appropriately might increase, with the pharmacist's review of the medications for drug-related problems. The function *persuasion* is absent in medication reviews that were performed together by pharmacist and physician (MR2) as they are working side by side, a two-way discourse is more likely to occur when they come to a decision together making necessary changes and resolving medication-related problems for the patient. Medication review that is performed solely by the physician (MR5) serves the function of *enablement,* as it provides an opportunity for them to review and rethink the medications they have prescribed, after having an overview of the patient's medications and health records. Medication review that is performed by physician and medical assistant (MR6) serves two functions. Firstly, involving medical assistant in the medication review process (e.g., brown bag review or medication reconciliation) changes the social context of the physician, which indicates *environment restructuring*[1]. Secondly, by providing a complete medication review or reconciliation lists of medication to the physicians, medical assistants *enabled* them to review and make changes to patient's medication when necessary.

Training

All three types of training (targeted at pharmacists (TG1), physicians (TG2) and medical assistants (TG3)) were mapped to the function *training,* as they served to equip healthcare professionals with practical skills to support the reduction of PIP.

Tool/Instrument(s)

Tool and instrument(s) have the function of *enablement,* as they served as guidelines to increase the means and capability of prescribers to prescribe more appropriately.

Feedback & audit

Both types of feedback & audit (feedback only (FA1) and feedback with discussion of improvement strategies (FA2)) serve the function of *persuasion,* since they prompt physicians to prescribe more appropriately through monitoring and feedback of their prescribing behavior. FA2 also served the function of *environmental restructuring,* where having someone to discuss strategies to improve prescribing changed the social context of the physician[1].

Table 2. Descriptions and Examples of Medication Review, Training, Tool/Instrument(s) and Feedback and audit

Intervention Element	Definition	Subtypes	Code	Examples	BCW Intervention Functions
Medication Review	'Structured evaluation of patient's medicines with the aim of optimizing medicines use and improving health outcomes'[1]	Pharmacist-led with feedback to physician	MR1	Clinical pharmacists performed drug therapy reviews for patients identified with high risk of polypharmacy and suggested drug therapy changes to the physicians by telephone, fax or in person. Physicians reviewed and endorsed recommendations[2].	• Persuasion • Environmental restructuring • Enablement
		Performed by pharmacist and physician	MR2	Clinical pharmacist reviewed patient charts to determine patients at greatest risk for MRPs and worked side by side with physicians to consult patient and resolve MRPs[3].	• Environmental restructuring • Enablement
		Performed by an external team of pharmacist(s) and/or physician(s)	MR3	A panel of 5 experts (physicians and pharmacists) not affiliated with the MCO or the academic medical center performed a peer review of the drugs to be included in the intervention and their corresponding alternative medications[4].	• Persuasion • Environmental restructuring • Enablement
		Performed by pharmacist (but not the one conveying feedback)	MR4	A clinical pharmacologist performed a thorough medication review of the selected patients, which was sent to the medication consultant. The medication consultant offered a visit at the general practitioner to discuss potential changes to the individual patient's medication[5].	• Persuasion • Environmental restructuring • Enablement
		Performed by physician	MR5	A letter was sent to selected patients to encourage them to make an appointment with their primary care physician for a medication review. Physicians were provided with patient-specific medication management report and clinical practice guidelines for managing polypharmacy[6].	• Enablement
		Performed by physician and medical assistant	MR6	MA performed brown bag review and GPs reviewed the medication systematically using tools (PRISCUS list or MAI) to reduce PIM[7].	• Environmental restructuring • Enablement
Training	Imparting skills required to carry out intervention to improve prescribing[8]	For pharmacists	TG1	Pharmacists attended tutorial by the study pharmacist to ensure standardized method of medication review[9].	• Training
		For physicians	TG2	20 GPs were trained to use STOPP criteria[10].	• Training
		For medical assistants	TG3	MAs were trained to perform brown bag reviews[7].	• Training

Tool/ instrument (s)	Checklist/guideline(s) used to identify medication-related problems or measure medication appropriateness	-	TI1	Pharmacist identified potential MRPs using START/STOPP criteria to be addressed with the provider[11].	• Enablement
Feedback & audit	Monitoring and evaluation of physician's prescribing patterns	Feedback only	FA1	Retrospective DUR identified patients at risk of drug injury. Main prescribing GP of identified patient received a personalized feedback letter containing patient-specific information and clinical practice guidelines[12].	• Persuasion
		Feedback with discussion of improvement strategies	FA2	A quality improvement tool was used to track PIM prescribing and individualized feedback were mailed to PCPs monthly. A geriatrician and geriatric clinical pharmacist met face to face with each PCP to review his/her first feedback form and discuss improvement strategies[13].	• Persuasion • Environmental restructuring

Abbreviations: BCW = Behaviour Change Wheel; MRP = medication-related problem; MCO = managed care organization; MA = medical assistant; GP = general practitioner; PIM = potentially inappropriate medication; DUR = drug utilization review; PCP = primary care provider

Medication therapy management and Education

Both medication therapy management and education were mapped to the function of *education* as they served to increase patients' knowledge and understanding about their medication regimen and educate healthcare professionals about PIP respectively.

Shared decision-making, Patient interview, Medication reconciliation and Comprehensive geriatric assessment

Intervention elements including shared decision-making, patient interview, medication reconciliation and comprehensive geriatric assessment performed the function of *enablement* as they increased the means or capability of physicians to prescribe more appropriately by providing physicians with more in-depth and holistic information about the patient.

Table 3. Descriptions and Examples of Medication therapy management, Shared decision-making, Clinical decision support, Education and Patient Interview

Intervention Element	Definition	Subtypes	Code	Examples	BCW Intervention Functions
Medication therapy management	'Providing verbal education and training designed to enhance patient understanding and appropriate use of his/her medications'[14]	-	MTM1	Patients will be provided with comprehensive counseling and specific adherence strategies (information about medications and administration) by the pharmacist[15].	• Education
Shared decision-making	Narrative based doctor-patient dialogue reflecting treatment targets and priorities of the patient[16]	-	SDM1	GPs met with patients 3 times within 12 months. First session was aimed at identifying patient's priorities in life (could be non-medical) and carving out treatment targets based on this information. Second session was a "brown bag review". On the third session, GPs discussed with patients goal attainment, changes in medication and treatment targets for the future[16].	• Enablement

Clinical decision support	'Technological applications that provide clinicians, staff, patients or other individuals with knowledge and person-specific information, intelligently filtered or presented at appropriate times, to enhance health and health care'[17]	-	CDS1	GP recorded medication and diagnoses in STRIPA and performed structured drug review using the software. STRIPA is a Dutch software-based tool that 1) highlights predictable adverse medication effects, 2) advises safe and appropriate therapy using STOPP/START criteria, 3) monitors for interactions and 4) provides appropriate dosing in accordance with renal function[18].	• Environmental restructuring • Enablement
Education	Increasing knowledge or understanding about PIP[8]	For physicians	ED1	Physicians in the intervention group received: (1) a detailed educational brochure listing PIMs, (2) a list of suggested PIM alternative medications (independently suggested and reviewed by 5 geriatricians and pharmacists not affiliated with the MCOs)[4].	• Education
		For physicians and nurses	ED2	PCPs and nurses underwent tutorial on PIMs[19].	• Education
Patient Interview	'Asking patient about how, when and why the patient takes each medication, as well as about any adverse reactions, allergies or issues with medication cost the patient may have experienced'[20]	Performed by physician	PI1	During the consultation, patients were interviewed on drugs currently being taken, dosage and frequency and the condition for which the medication had been prescribed[21].	• Enablement
		Performed by healthcare professional other than physician	PI2	Patients received a 30-60 min face to face consultation with the pharmacist at the clinic. Prior to the consultation, pharmacist reviewed patient's medical records. During the consultation, pharmacists interviewed patients for medication history, adherence and knowledge[22].	• Environmental restructuring • Enablement

Abbreviations: BCW = Behaviour Change Wheel; MCO = managed care organization; GP = general practitioner; PIM = potentially inappropriate medication; PCP = primary care provider

Clinical decision support

As an intervention element, clinical decision support served the functions of *environmental restructuring* by providing infrastructural support (changing physical context) and *enablement* by increasing physicians' means to prescribe appropriately.

Multidisciplinary team, Case conference and Peer support

Intervention elements including multidisciplinary team, case conference and peer support all performed the functions of *environmental restructuring* and *enablement. Environmental restructuring* was present as the involvement of other physicians and healthcare professionals changed the social context of the physician, whereas *enablement* was mapped as support from co-workers increases the physician's means to prescribe more appropriately.

Table 4. Descriptions and Examples of Medication Reconciliation, Multidisciplinary team, Comprehensive Geriatric Assessment, Case conference and Peer support

Intervention Element	Definition	Code	Examples	BCW Intervention Functions
Medication reconciliation	'The process of creating the most accurate list possible of all medications a patient is taking — including drug name, dosage, frequency, and route'[23]	MRC1	HCA reconciled all patient's medications, which patient was instructed to bring in its original packaging[24].	• Enablement
Multidisciplinary team	Involvement of healthcare professionals from more than two disciplines to address PIP in a patient	MT1	Patient attended a shared medical appointment co-facilitated by a pharmacist, health psychologist, nurse practitioner, and physician, and consisted of interactive discussions about polypharmacy, adherence, and patients' beliefs about medications[25].	• Environmental restructuring • Enablement
Comprehensive Geriatric Assessment	'A multidimensional, multidisciplinary process which identifies medical, social and functional needs'[26]	CGA1	Complete geriatric assessment was carried out by geriatrician at geriatric day clinic[27].	• Enablement
Case conference	Meeting of a multidisciplinary team of healthcare professionals to discuss an individual patient's case or multiple patients' cases[28]	CC1	Two physicians, a pharmacist and a nurse reviewed the list of drugs and the diagnoses of a subgroup of the experimental group in a case conference[28].	• Environmental restructuring • Enablement
Peer support	Discussions between physicians for decision-making[29]	PS1	GPs engaged in group discussion about their prescribing behaviors facilitated by peer academic detailer[30].	• Environmental restructuring • Enablement

Abbreviations: BCW = Behaviour Change Wheel; GP = general practitioner; HCA = health care assistant

DISCUSSION

Our results indicate that more than 80% of the interventions identified were complex with multi-modal approaches that comprise an average of 2.5 elements. This corroborates with past systematic reviews[29,30] that also identified most interventions as being complex. Furthermore, the intervention elements were targeted at various stakeholders. For instance, *Medication therapy management* aims to educate patients, *training* serves to equip healthcare providers with skills to improve prescribing, while *clinical decision support* provides infrastructural support. Taken together, these highlight the fact that PIP is a multi-faceted problem and a multi-prong approaches have been adopted to change behaviours of stakeholders at the patient, healthcare provider and organization levels. *Medication review* is the most frequently adopted intervention element, much more so than *tool/instrument* and *clinical decision support*. It is likely that this is due to PIP is a highly variable problem that varies in accordance with the individual clinical context. The determination of medication appropriateness therefore requires not only theoretical knowledge, but also clinical judgment and experience. As such, the involvement of a pharmacist and physician

in the medication review process is crucial for sound decisions to be made to achieve optimal outcomes for patients.

On the other hand, medication reviews are often time-consuming, making it a challenge to implement them in busy clinical practice[31,32]. While physicians generally appreciated support from pharmacists, some studies have also noted that collaboration between pharmacists and physicians requires trust and rapport, which take time to develop[33,34]. Therefore, although medication review was widely adopted as a strategy to reduce PIP, a systems-oriented approach to its implementation is needed for it to function as intended. *Case Conference* and *Peer support* were found to be the least frequently adopted intervention elements. It is likely that physicians were already seeking advice from peers when they encounter more complex cases, albeit on an informal and ad-hoc basis. Notably, 13 studies that adopted the element *Shared decision-making* were all published in the last five years i.e. 2014 to January 2019. This could be attributed to the shift in recent years towards patient-centered care, where emphasis is placed on prioritizing individual patient's needs and expectations[35]. This is particularly relevant in the context of PIP where stopping medications can be challenging for patients and that they tend to heed the advice of healthcare professionals only if they trust the latter[36]. In order to establish trust, it is essential for healthcare professionals to consider their concerns, thoughts and expectations.

Environmental restructuring and *enablement* were the two BCW intervention functions most frequently mapped to the 14 intervention elements. *Environmental restructuring* constitutes a change in either the physical or social context[1]. This suggests that inadequate infrastructural and social support for prescribers was being addressed. *Enablement*, on the other hand, involves increasing prescribers' opportunities or capabilities to prescribe appropriately through addressing barriers that limit prescribers' ability to prescribe optimally, such as incomplete information about patients.

Our findings will be useful in informing the development of a care intervention that will undergo feasibility testing in the second of three phases of the wider project. The anticipated product will be an effective, feasible and scalable physician-pharmacist collaborative care intervention to improve prescribing for older adults receiving outpatient care at public hospitals in Singapore.

Strengths and Limitations

We aimed to achieve methodological rigour by adhering closely to the scoping review framework proposed by Arksey & O'Malley[2] and applying the recommendations outlined by Levac *et al.*[3] and JBI[4]. A comprehensive search in both peer-reviewed and grey literature was performed and the final search strategy was developed after several rounds of iteration. We documented all search iterations attempted and systematic decisions the study team made along the way, in order to retain precise record of how the eventual search strategy was finalized. Following recommendations proposed by JBI, a step-by-step protocol was developed prior to undertaking the scoping review and our research question were clearly outlined in the format of 'Population, Concept, Context'. These steps helped to provide a clear direction and focus throughout the review process. The reviewers also met frequently to clarify doubts, as recommended by Levac *et al.*

Our initial search yielded a substantial number of titles and abstracts, which could suggest that our search strategy lacked specificity. However, given the lack of standardized terms and definitions (e.g., for the concept of 'polypharmacy') available on this subject, a broad array of search terms was used to capture as many studies relevant to our research question as possible. Due to feasibility reasons, language restrictions were imposed during literature search and study selection, which could result in the omission of relevant studies and underrepresentation of available literature. A limit was also placed on the year of publication of included studies, but this was to ensure that interventions identified were relevant to current healthcare contexts. Intervention elements and functions were only coded when explicitly stated or observed. Thus, coding was limited by the extent of intervention and methodological details reported. We also did not perform the sixth stage of the Arksey and O'Malley framework i.e. the consultation exercise. This stage will be replaced by a separate Delphi study, where findings from this scoping review will be presented to a panel of clinical experts to elicit their opinions on the relevance of our findings in local prescribing contexts.

As the intention for conducting our scoping review was to mainly focus on identifying all the intervention elements that have been implemented in the outpatient settings, interactions between intervention elements within an intervention package and the effectiveness or outcomes of these interventions were not examined. It would be interesting to explore the intervention elements that are most often bundled together and the effect these elements have on one another and on the

eventual outcome in a separate work. This could provide valuable evidence on the effectiveness of separate intervention elements when combined.

CONCLUSION

This review represents the first scoping review performed to identify elements of care interventions that address PIP among older adults in the outpatient setting. The wide range of intervention elements found were characterized based on the functions they perform using the BCW intervention functions adapted from Michie *et al*[1]. The findings from this review would thus provide valuable information and guidance when designing a theory- and evidence-based complex intervention to reduce PIP. Furthermore, a theoretical framework is applied in the synthesis and analysis of data, which could be regarded as an adaptation of the scoping review methodology given that there is currently no formalized approach to data synthesis. Further investigation can be explored to analyze interactions between different elements within an intervention and how they influence effectiveness in improving prescribing quality for older patients.

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FOOTNOTE

Contributors: KY and JQL conducted the scoping review, participated in data extraction and synthesis, and wrote the first draft of the paper for submission. JQL is the corresponding author and has taken the primary responsibility for communication with the journal during the manuscript submission, peer review and publication process, and has ensured that all the journal's administrative requirements, such as providing details of authorship, and gathering conflict of interest forms and statements, are properly completed. YYD, KTT, WA and PL provided specific content clinical expertise to inform the discussion and implications of the study results (from the perspective of geriatrician, pharmacist and researcher). YLM was the study librarian on the study and contributed to the search strategy as well as draft and review of the methods of the manuscript. All seven authors reviewed the accuracy and integrity of the work.

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Data sharing statement: Readers interested in using our database for specific purposes related to their respective research are invited to do so by contacting the first author through their corresponding email address.

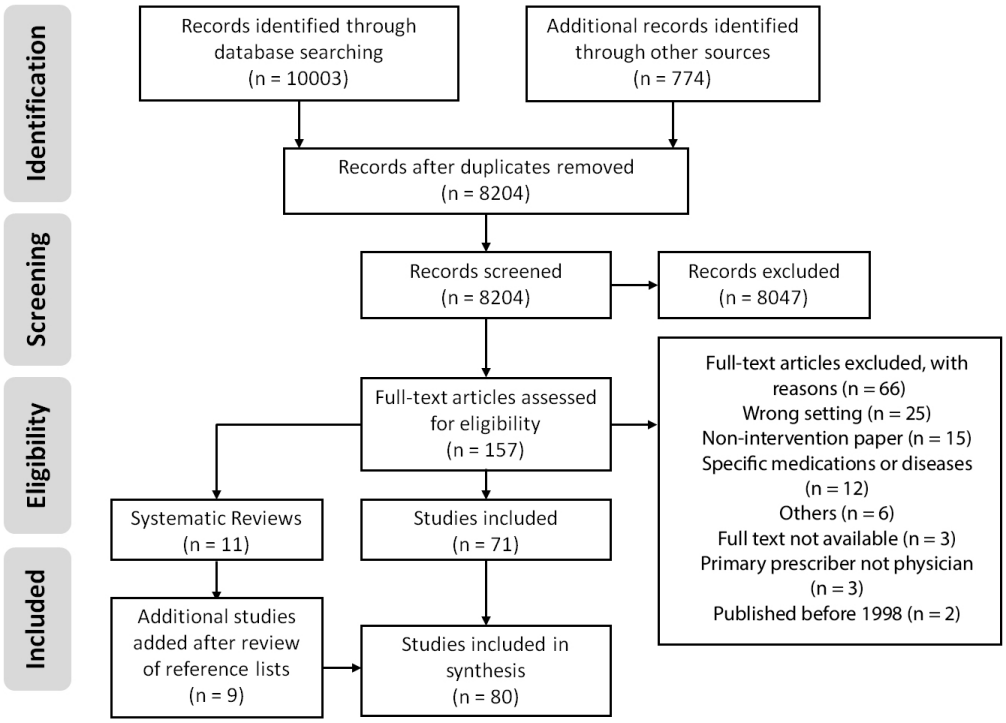

Figure 1. PRISMA flow diagram of study selection process.

225x164mm (150 x 150 DPI)

Research Question: What intervention elements *(Concept (1))* have been adopted to reduce inappropriate prescribing *(Concept (2))* among older adults *(Population (1))* with multimorbidity *(Population (2))* in outpatient care *(Context)*?					
	~~Population (1)~~ **~~Older adults~~** *	Population (2) **Multimorbidity**	Concept (1) **Interventions**	Concept (2) **Reduce inappropriate prescribing**	Context **Outpatient care**
MeSH Terms	~~Aged~~	Comorbidity Multimorbidity	Medication Reconciliation Patient Care Management Case management Drug Utilization Review Guideline Adherence Decision Support Systems, Clinical	Inappropriate Prescribing Polypharmacy Potentially Inappropriate Medication List Deprescriptions Drug Prescriptions Practice Patterns, Physicians'	Ambulatory Care Outpatient Clinics, Hospital Community Health Centers Primary Health Care
Key Words	~~Aged~~ ~~Elderly~~ ~~Senior~~ ~~Seniors~~ ~~Older person~~ ~~Older persons~~ ~~Older people~~ ~~Older adult~~ ~~Older adults~~ ~~Older patient~~ ~~Older patients~~ ~~Older population~~ ~~Older subject~~ ~~Older subjects~~ ~~Geriatric~~ ~~Geriatrics~~	Comorbidity Multimorbidity	Intervention Interventions Implementation Strategy Strategies Behavior change technique Medication review Medication reviews Medication management Medication therapy management	Prescribing Prescription Prescriptions Medication Medications Medicine Medicines Drug prescription Drug prescriptions Inappropriate prescribing Deprescribing Physician practice pattern Physician practice patterns Clinical practice pattern Clinical practice patterns	Outpatient Ambulatory Care Clinic Clinics Primary Care Primary Healthcare General Practice

* Search terms under Population (1) were removed after several iterative searches to increase the breadth of our search. However, we specified under our eligibility criteria to include studies as long as they involved adults above the age of 65.

PubMed Search Strategy

Search ((((Comorbidity[MeSH Terms]) OR (Multimorbidity[MeSH Terms]) OR "Polypharmacy"[Mesh])) OR ((((comorbidity[Title/Abstract] OR multimorbidity[Title/Abstract] OR polypharmacy[Title/Abstract])) OR (comorbidity[Text Word] OR multimorbidity[Text Word] OR polypharmacy[Text Word]))))) AND (((((("Medication Reconciliation"[Mesh] OR "Patient Care Management"[Mesh] OR "Case Management"[Mesh] OR "Drug Utilization Review"[Mesh] OR "Guideline Adherence"[Mesh] OR "Decision Support Systems, Clinical"[Mesh])) OR ((((intervention[Title/Abstract] OR interventions[Title/Abstract] OR implementation[Title/Abstract] OR strategy[Title/Abstract] OR strategies[Title/Abstract] OR medication review[Title/Abstract] OR medication reviews[Title/Abstract] OR medication management[Title/Abstract] OR medication therapy management[Title/Abstract] OR behavior change technique[Title/Abstract])) OR (intervention[Text Word] OR interventions[Text Word] OR implementation[Text Word] OR strategy[Text Word] OR strategies[Text Word] OR medication review[Text Word] OR medication reviews[Text Word] OR medication management[Text Word] OR medication therapy management[Text Word] OR behavior change technique[Text Word]))))) AND ((("Inappropriate Prescribing"[Mesh] OR "Potentially Inappropriate Medication List"[Mesh] OR "Deprescriptions"[Mesh] OR "Drug Prescriptions"[Mesh] OR "Practice Patterns, Physicians'"[Mesh])) OR ((((prescribing[Title/Abstract] OR prescription[Title/Abstract] OR prescriptions[Title/Abstract] OR medication[Title/Abstract] OR medications[Title/Abstract] OR medicine[Title/Abstract] OR medicines[Title/Abstract] OR drug prescription[Title/Abstract] OR drug prescriptions[Title/Abstract] OR inappropriate prescribing[Title/Abstract] OR deprescribing[Title/Abstract] OR physician practice pattern[Title/Abstract] OR physician practice patterns[Title/Abstract] OR clinical practice pattern[Title/Abstract] OR clinical practice patterns[Title/Abstract])) OR (prescribing[Text Word] OR prescription[Text Word] OR prescriptions[Text Word] OR medication[Text Word] OR medications[Text Word] OR medicine[Text Word] OR medicines[Text Word] OR drug prescription[Text Word] OR drug prescriptions[Text Word] OR inappropriate prescribing[Text Word] OR deprescribing[Text Word] OR physician practice pattern[Text Word] OR physician practice patterns[Text Word] OR clinical practice pattern[Text Word] OR clinical practice patterns[Text Word]))))) AND ((("Ambulatory Care"[Mesh] OR "Outpatient Clinics, Hospital"[Mesh] OR "Community Health Centers"[Mesh] OR "Primary Health Care"[Mesh])) OR ((((Outpatient[Title/Abstract] OR Ambulatory Care[Title/Abstract] OR Clinic[Title/Abstract] OR Clinics[Title/Abstract] OR Primary Care[Title/Abstract] OR Primary Healthcare[Title/Abstract] OR General Practice[Title/Abstract])) OR (Outpatient[Text Word] OR Ambulatory Care[Text Word] OR Clinic[Title/Abstract] OR Clinics[Text Word] OR Primary Care[Text Word] OR Primary Healthcare[Text Word] OR General Practice[Text Word])))))) AND (("1998/01/01"[PDat] : "2019/12/31"[PDat]) AND English[lang])

BCW intervention function definitions and examples

Intervention Function	Definition	Example of intervention function
Education	Increasing knowledge or understanding	Providing information to promote healthy eating
Persuasion	Using communication to induce positive or negative feelings or stimulate action	Using imagery to motivate increases in physical activity
Incentivisation	Creating an expectation of reward	Using prize draws to induce attempts to stop smoking
Coercion	Creating an expectation of punishment or cost	Raising the financial cost to reduce excessive alcohol consumption
Training	Imparting skills	Advanced driver training to increase safe driving
Restriction	Using rules to reduce the opportunity to engage in the target behaviour (or to increase the target behaviour by reducing the opportunity to engage in competing behaviours)	Prohibiting sales of solvents to people under 18 to reduce use for intoxication
Environmental restructuring	Changing the physical or social context	Providing on-screen prompts for GPs to ask about smoking behaviour
Modelling	Providing an example for people to aspire to or imitate	Using TV drama scenes involving safe sex practices to increase condom use
Enablement	Increasing means/reducing barriers to increase capability (beyond education and training) or opportunity (beyond environmental restructuring)	Behavioral support for smoking cessation, medication for cognitive deficits, surgery to reduce obesity, prostheses to promote physical activity

Taken from: Michie S, Atkins L, West R. *The Behavior Change Wheel: A Guide to Designing Interventions*. London, UK: Silverback Publishing 2014.

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Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	1
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	3-4
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	5
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	NA
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	6
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	6
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	Supplementary File 2
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	5-7
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	7
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	7
Critical appraisal of individual	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe	NA

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
sources of evidence§		the methods used and how this information was used in any data synthesis (if appropriate).	
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	7-8
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	Figure 1
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	Table 1 (pages 8-9)
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	NA
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	8-14
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	8-14
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	14-15
Limitations	20	Discuss the limitations of the scoping review process.	16
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	17
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	24

JBI = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.

* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.

† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).

‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.

§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

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Intervention Elements to Reduce Inappropriate Prescribing for Older Adults with Multimorbidity Receiving Outpatient Care: A Scoping Review

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Intervention Elements to Reduce Inappropriate Prescribing for Older Adults with Multimorbidity Receiving Outpatient Care: A Scoping Review

ABSTRACT

Objective: Polypharmacy occurs in approximately 30% of older adults aged 65 years or more, particularly among those with multimorbidity. With polypharmacy, there is an associated risk of potentially inappropriate prescribing (PIP). The aims of this scoping review were to (i) identify the intervention elements that have been adopted to reduce PIP in the outpatient setting and (ii) determine the Behaviour Change Wheel (BCW) intervention functions performed by each of the identified intervention elements.

Design: Scoping Review

Data sources: PubMed, Cumulative Index to Nursing and Allied Health Literature (CINAHL), EMBASE, Web of Science and Cochrane Library databases, grey literature sources, six key geriatrics journals and the reference lists of review papers.

Study selection: All studies reporting an intervention or strategy that addressed PIP in the older adult population (age ≥65) with multimorbidity in the outpatient setting and in which the primary prescriber is the physician.

Data extraction: Data extracted from the included studies can be broadly categorized into (i) publication details (ii) intervention details and (iii) results. This was followed by data synthesis and analysis based on the BCW framework.

Results: Of 8204 studies yielded, 80 studies were included in the final analysis and 14 intervention elements were identified. An average of two to three elements were adopted in each intervention. The three most used intervention elements were medication review (70%), training (26.3%) and tool/instrument(s) (22.5%). Among medication reviews, 60% involved pharmacists. The 14 intervention elements were mapped onto five intervention functions: "*education*", "*persuasion*", "*training*", "*environmental restructuring"* and "*enablement"*.

Conclusion: PIP is a multi-faceted problem that involves multiple stakeholders. Interventions to address PIP have multiple elements targeting the behaviour of different stakeholders. The intervention elements and their corresponding functions identified in this scoping review will inform the design of complex interventions that aim to reduce PIP.

Keywords: elderly; geriatrics; polypharmacy; ambulatory care; behaviour change wheel; intervention components

ARTICLE SUMMARY

Strength and limitations of this study:

- This is the first attempt to map the extent and nature of information on this topic in both peer-reviewed and grey literature.
- The results from this review can be used to guide the design of complex interventions to reduce PIP among older adults.
- Consultation with experts and stakeholders was initiated at the time of writing and will be reported in a separate work.
- The effectiveness or outcomes of interventions were not examined in the present study.
- This review may not be fully comprehensive due to the time period and language restrictions imposed during literature search and study selection.

ABBREVIATIONS

ADE, Adverse Drug Events; BCW, Behaviour Change Wheel; CINAHL, Cumulative Index to Nursing and Allied Health Literature; COM-B, 'Capability', 'Opportunity', 'Motivation' and 'Behaviour'; DUR, Drug Utilization Review; GP, General Practitioner; HCA; Health Care Assistant; JBI, Joanna Briggs Institute; MA, Medical Assistant; MAI, Medication Appropriateness Index; MCO, Managed Care Organization; MeSH, Medical Subject Headings; MRP, Medication-Related Problem; PCP, Primary Care Provider; PIP, Potentially Inappropriate Prescribing; PRISMA, Preferred Reporting Items for Systematic Reviews and Meta-Analyses; START, Screening Tool to Alert to Right Treatment; STOPP, Screening Tool of Older Person's Potentially Inappropriate Prescriptions; STRIPA, Systematic Tool to Reduce Inappropriate Prescribing-Assistant

INTRODUCTION

Polypharmacy, commonly defined as the use of five or more medications daily, is a widespread phenomenon among older adults as they tend to develop multiple chronic diseases or multimorbidity with age[1]. Polypharmacy among community-dwelling older people is a global problem, with its prevalence ranging from 11.5% among rural residents of China to 43.3% in Australia according to a 2019 World Health Organization report[2]. Furthermore, the prevalence of polypharmacy shows an increasing trend worldwide[3]. A longitudinal, cohort study of over 2,000 community-dwelling older adults aged 62 to 85 years in the US showed that the prevalence of polypharmacy increased from 30.6% to 35.8% between 2005 and 2011[4]. Similar trends have also been observed in other countries, including the UK, Netherlands, Belgium, Japan, South Korea and New Zealand[5–10]. Polypharmacy is a cause for concern as it predisposes older adults to potentially inappropriate prescribing (PIP), which occurs when medicines prescribed confer more harm than benefit[11]. Current clinical guidelines are designed to be disease-specific, and many do not take into consideration drug-disease and drug-drug interactions in their treatment recommendations[12,13]. In older adults, adverse drug events (ADE) are made even more unpredictable by age-related changes in pharmacokinetics and pharmacodynamics[14,15]. This problem is further exacerbated by the fact that clinical trials often exclude older adults, which means approved drug doses may not be appropriate for geriatric patients[16].

It is estimated that up to 50% of older adults receive at least one unnecessary medication, and the incidence of PIP increases significantly with polypharmacy[17,18]. Older adults with at least 2 PIP indicators based on the Screening Tool of Older Person's Potentially Inappropriate Prescriptions (STOPP) criteria were shown to be twice as likely to experience ADE[19]. Apart from drug-related problems, older adults with PIP also reported poorer functional status, reduced health-related quality of life and increased health care utilization, including more frequent emergency department visits and hospitalizations[20–22]. Given the high prevalence of PIP and its adverse outcomes, it is therefore imperative for appropriate measures to be implemented to improve prescribing for older adults. With rising concern on suboptimal prescribing both internationally and at home, a three-phase implementation research project aiming to reduce PIP among older adults is underway. The first phase includes a literature review to examine interventions to reduce PIP among older adults with multimorbidity receiving outpatient care.

While there have been several systematic reviews performed to explore interventions that address PIP, these reviews included a limited number of studies as they focused only on specific study types (e.g., randomized controlled trials[23]) or specific intervention types (e.g., computerized decision support systems[24] and pharmacist-led medication reviews[25]). Moreover, systematic reviews often restrict inclusion to studies that fulfill a certain standard of methodological rigour and reporting, which might result in the omission of a significant number of potentially relevant studies[26].

In addition, reviews of complex interventions can be challenging as there is currently no formal methodology for the synthesis of data from these studies[27]. There is also great variability among complex interventions in terms of their components and modes of delivery, which makes it even harder to perform comparative analyses[27]. To overcome this problem, a theoretical framework could be applied to organize and make sense of the data extracted. In this scoping review, the Behaviour Change Wheel (BCW) framework[28] was used. The BCW was developed by Michie and colleagues (2011) as a framework to systematically guide the development of interventions using theory. In the BCW framework, evidence-based principles of behavior change are represented in the core model of behavior: capability, opportunity, motivation and behavior (COM-B)[29]. COM-B identifies sources of behavior that could bring about a change, which are mapped to nine intervention functions: *education*, *persuasion*, *incentivisation*, *coercion*, *training*, *restriction*, *environmental restructuring*, *modeling* and *enablement*. This approach offers a systematic method of characterizing and analyzing intervention content. As such, in order to capture the breadth of intervention studies that have been conducted to address PIP, we adopted a scoping review methodology to identify all relevant information irrespective of study type and quality of their sources.

The aims of our scoping review were thus to: (i) identify intervention elements and within-element variations that have been adopted to reduce inappropriate prescribing among older adults in the outpatient setting and (ii) map the intervention elements to the BCW intervention functions for synthesis. The findings will contribute to the knowledge base to inform the development of a collaborative care intervention to reduce PIP, which will be tested in subsequent study phases. To our knowledge, there have been no scoping reviews published that map information on the extent and nature of care interventions to reduce PIP from both peer-reviewed and grey literature.

METHODS

The methodological framework developed by Arksey and O'Malley[30] was adopted, with application of recommendations proposed by Levac *et al.*[31] and the Joanna Briggs Institute (JBI)[32]. Five of the six stages outlined in the framework were performed: (i) identifying the research question; (ii) identifying relevant studies; (iii) selecting studies; (iv) charting data and (v) summarizing and reporting the results.

Identifying the research question

This scoping review was guided by the research question: "What intervention elements have been adopted to reduce inappropriate prescribing among older adults with multimorbidity in outpatient care?" The research question was formulated after several rounds of discussion within the study team (one physician (YYD), two pharmacists (KTT and WA) and three researchers (KY, JQL, PL). Following recommendation by JBI[32], the research question incorporated the elements "Population, Concept and Context".

Identifying the relevant studies

We started with five articles that are relevant to our research question and identified the keywords and Medical Subject Headings (MeSH) terms that were used to describe these articles. These search terms were then categorized into "Population", "Concept" and "Context" and additional keywords and MeSH terms were identified through searching their synonyms and the MeSH browser respectively. The final list of search terms can be found in Supplementary File 1.

We conducted a pilot search in Ovid MEDLINE. Using the five articles as a test of sensitivity and specificity, the search strategy was refined after several iterative searches. The eventual search strategy was then adapted for the remaining databases using the appropriate syntax. The following six electronic databases were searched on 28 January 2019: (i) PubMed; (ii) Cumulative Index to Nursing and Allied Health Literature (CINAHL); (iii) Web of Science; (iv) Embase (Ovid); (v) The Cochrane Library and (vi) Scopus. Our searches were limited to English Language only with publication date from January 1998 to the date performed (January 2019). The full electronic search strategy for PubMED is provided in Supplementary File 2.

We also performed a search for grey literature in February 2019 in 13 resources, including ClinicalTrials.gov (https://clinicaltrials.gov/), OpenGrey (http://www.opengrey.eu/), Science.gov (https://www.science.gov/) and WorldCat (https://www.worldcat.org/). In addition, six key geriatrics and gerontology journals were searched electronically: (i) Journal of the American Geriatrics Society; (ii) Age and Ageing; (iii) The Journals of Gerontology Series A; (iv) Archives of Gerontology and Geriatrics (v) BMC Geriatrics and (vi) European Geriatric Medicine. Various combinations of the following keywords were used: 'intervention' and 'inappropriate prescribing', combined with 'multimorbidity', 'comorbidity' and 'polypharmacy'. Where possible, language and publication date limits were imposed (as above).

Screening and study selection procedures

The eligibility criteria were developed based on the research question and further refined along the way as the reviewers became more familiar with the evidence base. Our inclusion criteria were: (i) original publications that describe an intervention or strategy that addresses PIP in a population that includes older adults (age ≥ 65 years); (ii) intervention was carried out in the outpatient setting; (iii) physicians were the prescribers and (iv) prescribing was not restricted to specific diseases or conditions e.g., hypertension, chronic obstructive pulmonary disease or specific medications e.g., opioids.

The screening was conducted in Covidence® and consisted of two stages. The first stage involved title and abstract screening, which was performed independently by two reviewers (KY and JQL). Reviewers met at the beginning, middle and end stages of the abstract review process to clarify doubts and establish a common understanding of the inclusion criteria, as recommended by Levac *et al.*[31]. In the second stage, the same reviewers similarly reviewed the full text articles independently, before meeting to discuss and resolve conflicts. A third reviewer (YYD) was involved in resolving conflicts where necessary. During the screening process, systematic reviews that were relevant to the research question were also identified and their reference lists were searched to garner additional primary studies for inclusion. The systematic review papers were not included in data extraction and synthesis.

Charting the data

A data charting form was developed and used to extract data from the included studies. The extracted information included: (i) publication details: author(s), year of publication, country of origin; (ii) intervention details: study type, participants, description of intervention and (iii) results: outcome measures. Charting of the first three studies was performed together by the two reviewers (KY and JQL) to establish a standardized method of extraction. Each reviewer then charted half of the remaining studies.

Collating, summarizing and reporting of results

The first step of data synthesis involved identifying the intervention elements present in each study. During full text screening of the 80 articles, a provisional list of common intervention elements implemented in the reported studies was identified by the reviewers (e.g., medication reviews, education and training, case conference, medication reconciliation, etc.) and the list was expanded and refined along the way. Coding of the intervention elements was performed independently by the two reviewers (KY and JQL), before meeting to compare, discuss and reach a consensus on the coding.

Application of Behaviour Change Framework

The intervention elements were then mapped to the BCW intervention functions: *education*, *persuasion*, *incentivisation*, *coercion*, *training*, *restriction*, *environmental restructuring*, *modeling* and *enablement.* The definitions and examples of the BCW intervention functions are outlined in Supplementary File 3. Two reviewers (KY and JQL) performed the mapping independently before discussing and finalizing the synthesis.

Patient and Public Involvement

Patients and/or members of the public were not involved in this scoping review.

RESULTS

Study selection and characteristics of included studies

The review selection process is summarized in Figure 1 using a Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flow diagram. The initial search yielded 8204 abstracts after removal of duplicates. After title and abstract screening and full text review, 71 studies were included. Eleven systematic review papers relevant to our research question were identified and their reference lists were searched, adding another 9 studies. A total of 80 studies were included for data extraction and synthesis (references to the included studies are provided in Supplementary File 4). They comprised 40 interventional studies, 13 observational studies, 13 study protocols, 13 conference abstracts and 1 report. The characteristics of the included studies are summarized in Table 1. The studies originated from 19 countries, with the majority from the US (n = 25, 32%). More than 60% of the included studies were published in the last five years i.e. 2014 to present.

Table 1. Characteristics of included studies

Characteristic	Frequency Count	Percentage
Study Type		
Interventional Studies	40	50.0%
Randomized Controlled Trial	17	21.3%
Pre-post study	9	11.3%
Cluster Randomized Controlled Trial	7	8.8%
Non-randomized trial	6	7.5%
Randomized Trial	1	1.3%
Observational Studies	13	16.3%
Prospective Cohort Study	10	12.5%
Retrospective Cohort Study	2	2.5%
Cross-sectional study	1	1.3%
Others	27	33.8%
Study Protocol	13	16.3%
Conference Abstract	13	16.3%
Report	1	1.3%
Publication Year		
1998 - 2003	8	10.0%
2004 - 2008	8	10.0%
2009 - 2013	15	18.8%
2014 - 2019	49	61.3%
Country of Origin		
US & Canada	31	38.8%
UK & Ireland	5	6.3%

Scandinavia	9	11.3%
Western Europe	25	31.3%
Asia	6	7.5%
Australia	3	3.8%
Others	1	1.3%

Intervention elements identified

14 intervention elements were identified from the included studies. Within each intervention element, variations were noted and coded separately to capture the differences in which the elements were performed (e.g., medication review performed by pharmacist or physician or both physician and pharmacist). The definitions of the 14 intervention elements are outlined in Tables 2, 3 and 4. *Medication review* was found to be the most frequently adopted intervention element (n=56; 70%), followed by *Training* (n=21; 26.3%)*, Tool/instrument(s)* (n=18; 22.5%)*, Feedback & audit* (n=15; 18.8%) and *Medication therapy management* (n=14; 17.5%). Of all medication reviews, 70% involved pharmacists (n=39; MR1, 2, 3 and 4), 27% were performed by physicians alone (n=15; MR5) and 2.5% were performed by physicians and medical assistants (n=2; MR6). *Case conference* and *Peer support* were the least frequently adopted intervention elements (n=3 and n=2 respectively). Interventions have an average of 2.5 elements, with more than 80% (n=65) consisting of more than one element. The highest number of elements present in a single intervention is eight[33].

Mapping of intervention elements to BCW intervention functions

The 14 intervention elements were mapped to five of the nine BCW intervention functions, namely *education, persuasion, training, environmental restructuring* and *enablement.* Tables 2, 3 and 4 summarize the 14 intervention elements and their corresponding intervention functions. No intervention elements were mapped to the remaining 4 intervention functions (*Incentivisation, Coercion, Restriction, Modelling*)[28]. *Environmental restructuring* and *enablement* were the two functions that were most commonly identified among the intervention elements (n = 11 and n = 16 out of 24).

Medication review

Pharmacist-led medication reviews (MR1), medication reviews conducted by an external team of pharmacist(s) and/or physician(s) (MR3) and medication reviews conducted by pharmacist(s) without communicating recommendations to the physician directly (MR4) were mapped to the same three functions. The first function *persuasion* was performed as the pharmacist communicated their recommendations to the physician, prompting them to reconsider their prescription for the respective patients. *Environmental restructuring* was also served, when presence of a pharmacist changed the social context of the physician[28]. The third function was *enablement,* as the physicians' means to prescribe appropriately could increase with the pharmacist's review of the medications for drug-related problems. The function *persuasion* was not identified in medication reviews that were performed together by a pharmacist and a physician (MR2), as the pharmacist and physician worked together to reach a decision to resolve medication-related problems for the patient. Medication review that was performed solely by a physician (MR5) served the function of *enablement,* as the medication review provided an opportunity for the physician to review and rethink the prescription, after having an overview of the patient's medications and health records. Medication review that was performed by a physician and a medical assistant (MR6) served two functions. Firstly, involving medical assistant in the medication review process (e.g., brown bag review or medication reconciliation) changed the social context of the physician, which indicates *environment restructuring*[28]. Secondly, by providing a complete medication review or reconciliation list of medication to the physicians, medical assistants *enabled* them to review and make changes to patient's medication when necessary.

Training

All three types of training (targeted at pharmacists (TG1), physicians (TG2) and medical assistants (TG3)) were mapped to the function *training,* as they served to equip healthcare professionals with practical skills to support the reduction of PIP.

Tool/Instrument(s)

Tool and instrument(s) were mapped to the function of *enablement,* as they served as guidelines to increase the means and capability of prescribers to prescribe more appropriately. Among the 18 studies that involved tool/instrument(s), the most commonly employed tools/instruments were the

STOPP criteria (n = 7; 38.9%), followed by Screening Tool to Alert to Right Treatment (START) (n = 5; 27.8%) and Beers criteria (n = 4; 22.2%).

Feedback & audit

Both types of feedback & audit (feedback only (FA1) and feedback with discussion of improvement strategies (FA2)) served the function of *persuasion,* since they prompted physicians to prescribe more appropriately through monitoring and feedback of their prescribing behavior. FA2 also served the function of *environmental restructuring,* as having someone to discuss strategies to improve prescribing changed the social context of the physician[28].

Table 2. Descriptions and Examples of Medication Review, Training, Tool/Instrument(s) and Feedback and audit

Intervention Element	Definition	Subtypes	Code	Examples	BCW Intervention Functions
Medication Review	'Structured evaluation of patient's medicines with the aim of optimizing medicines use and improving health outcomes'[34]	Pharmacist-led with feedback to physician	MR1	Clinical pharmacists performed drug therapy reviews for patients identified with high risk of polypharmacy and suggested drug therapy changes to the physicians by telephone, fax or in person. Physicians reviewed and endorsed recommendations[35].	• Persuasion • Environmental restructuring • Enablement
		Performed by pharmacist and physician	MR2	Clinical pharmacist reviewed patient charts to determine patients at greatest risk for MRPs and worked side by side with physicians to consult patient and resolve MRPs[36].	• Environmental restructuring • Enablement
		Performed by an external team of pharmacist(s) and/or physician(s)	MR3	A panel of 5 experts (physicians and pharmacists) not affiliated with the MCO or the academic medical center performed a peer review of the drugs to be included in the intervention and their corresponding alternative medications[37].	• Persuasion • Environmental restructuring • Enablement
		Performed by pharmacist (but not the one conveying feedback)	MR4	A clinical pharmacologist performed a thorough medication review of the selected patients, which was sent to the medication consultant. The medication consultant offered a visit at the general practitioner to discuss potential changes to the individual patient's medication[38].	• Persuasion • Environmental restructuring • Enablement
		Performed by physician	MR5	A letter was sent to selected patients to encourage them to make an appointment with their primary care physician for a medication review. Physicians were provided with patient-specific medication management report and clinical practice guidelines for managing polypharmacy[39].	• Enablement
		Performed by physician and medical assistant	MR6	MA performed brown bag review and GPs reviewed the medication systematically using tools (PRISCUS list or MAI) to reduce potentially inappropriate medications[40].	• Environmental restructuring • Enablement
Training	Imparting skills required to carry out intervention to improve prescribing[28]	For pharmacists	TG1	Pharmacists attended tutorial by the study pharmacist to ensure standardized method of medication review[41].	• Training
		For physicians	TG2	20 GPs were trained to use STOPP criteria[42].	• Training
		For medical assistants	TG3	MAs were trained to perform brown bag reviews[40].	• Training

Tool/ instrument (s)	Checklist/guideline(s) used to identify medication-related problems or measure medication appropriateness	-	TI1	Pharmacist identified potential MRPs using START/STOPP criteria to be addressed with the provider[43].	• Enablement
Feedback & audit	Monitoring and evaluation of physician's prescribing patterns	Feedback only	FA1	Retrospective DUR identified patients at risk of drug injury. Main prescribing GP of identified patient received a personalized feedback letter containing patient-specific information and clinical practice guidelines[44].	• Persuasion
		Feedback with discussion of improvement strategies	FA2	A quality improvement tool was used to track PIP and individualized feedback were mailed to PCPs monthly. A geriatrician and geriatric clinical pharmacist met face to face with each PCP to review his/her first feedback form and discuss improvement strategies[45].	• Persuasion • Environmental restructuring

Abbreviations: BCW = behaviour change wheel; DUR = drug utilization review; GP = general practitioner; MA = medical assistant; MAI = medication appropriateness index; MCO = managed care organization; MRP = medication-related problem; PCP = primary care provider; PIP = potentially inappropriate prescribing; START = screening tool to alert to right treatment; STOPP = screening tool of older person's potentially inappropriate prescriptions

Medication therapy management and Education

Both medication therapy management and education were mapped to the function of *education,* since they served to increase patients' knowledge and understanding about their medication regimen and educate healthcare professionals about PIP respectively.

Shared decision-making, Patient interview, Medication reconciliation and Comprehensive geriatric assessment

The intervention elements shared decision-making, patient interview, medication reconciliation and comprehensive geriatric assessment performed the function of *enablement,* as they increased the means or capability of physicians to prescribe more appropriately by providing in-depth and holistic information about the patient.

Table 3. Descriptions and Examples of Medication therapy management, Shared decision-making, Clinical decision support, Education and Patient Interview

Intervention Element	Definition	Subtypes	Code	Examples	BCW Intervention Functions
Medication therapy management	'Providing verbal education and training designed to enhance patient understanding and appropriate use of his/her medications'[46]	-	MTM1	Patients will be provided with comprehensive counseling and specific adherence strategies (information about medications and administration) by the pharmacist[47].	• Education
Shared decision-making	Narrative based doctor-patient dialogue reflecting treatment targets and priorities of the patient[48]	-	SDM1	GPs met with patients 3 times within 12 months. First session was aimed at identifying patient's priorities in life (could be non-medical) and carving out treatment targets based on this information. Second session was a "brown bag review". On the third session, GPs discussed with patients goal attainment, changes in medication and treatment targets for the future[48].	• Enablement

Clinical decision support	'Technological applications that provide clinicians, staff, patients or other individuals with knowledge and person-specific information, intelligently filtered or presented at appropriate times, to enhance health and health care'[49]	-	CDS1	GP recorded medication and diagnoses in STRIPA and performed structured drug review using the software. STRIPA is a Dutch software-based tool that 1) highlights predictable adverse medication effects, 2) advises safe and appropriate therapy using STOPP/START criteria, 3) monitors for interactions and 4) provides appropriate dosing in accordance with renal function[50].	• Environmental restructuring • Enablement
Education	Increasing knowledge or understanding about PIP[28]	For physicians	ED1	Physicians in the intervention group received: (1) a detailed educational brochure listing potentially inappropriate medications, (2) a list of suggested alternative medications (independently suggested and reviewed by 5 geriatricians and pharmacists not affiliated with the MCOs)[37].	• Education
		For physicians and nurses	ED2	PCPs and nurses underwent tutorial on PIP[51].	• Education
Patient Interview	'Asking patient about how, when and why the patient takes each medication, as well as about any adverse reactions, allergies or issues with medication cost the patient may have experienced'[52]	Performed by physician	PI1	During the consultation, patients were interviewed on drugs currently being taken, dosage and frequency and the condition for which the medication had been prescribed[53].	• Enablement
		Performed by healthcare professional other than physician	PI2	Patients received a 30-60 min face to face consultation with the pharmacist at the clinic. Prior to the consultation, pharmacist reviewed patient's medical records. During the consultation, pharmacists interviewed patients for medication history, adherence and knowledge[54].	• Environmental restructuring • Enablement

Abbreviations: BCW = Behaviour Change Wheel; GP = general practitioner; MCO = managed care organization; PCP = primary care provider; PIP = potentially inappropriate prescribing; START = screening tool to alert to right treatment; STOPP = screening tool of older person's potentially inappropriate prescriptions; STRIPA = systematic tool to reduce inappropriate prescribing-assistant

Clinical decision support

As an intervention element, clinical decision support served the function of *environmental restructuring* by providing infrastructural support (changing physical context) and the function of *enablement* by increasing physicians' means to prescribe appropriately.

Multidisciplinary team, Case conference and Peer support

The intervention elements multidisciplinary team, case conference and peer support all performed the functions of *environmental restructuring* and *enablement. Environmental restructuring* was identified as the involvement of other physicians and healthcare professionals changed the social context of the physician, whereas *enablement* was served as support from co-workers increased the physician's means to prescribe more appropriately.

Table 4. Descriptions and Examples of Medication Reconciliation, Multidisciplinary team, Comprehensive Geriatric Assessment, Case conference and Peer support

Intervention Element	Definition	Code	Examples	BCW Intervention Functions
Medication reconciliation	'The process of creating the most accurate list possible of all medications a patient is taking — including drug name, dosage, frequency, and route'[55]	MRC1	HCA reconciled all patient's medications, which patient was instructed to bring in its original packaging[56].	• Enablement
Multidisciplinary team	Involvement of healthcare professionals from more than two disciplines to address PIP in a patient	MT1	Patient attended a shared medical appointment co-facilitated by a pharmacist, health psychologist, nurse practitioner, and physician, and consisted of interactive discussions about polypharmacy, adherence, and patients' beliefs about medications[57].	• Environmental restructuring • Enablement
Comprehensive Geriatric Assessment	'A multidimensional, multidisciplinary process which identifies medical, social and functional needs'[58]	CGA1	Complete geriatric assessment was carried out by geriatrician at geriatric day clinic[59].	• Enablement
Case conference	Meeting of a multidisciplinary team of healthcare professionals to discuss an individual patient's case or multiple patients' cases[60]	CC1	Two physicians, a pharmacist and a nurse reviewed the list of drugs and the diagnoses of a subgroup of the experimental group in a case conference[60].	• Environmental restructuring • Enablement
Peer support	Discussions between physicians for decision-making[61]	PS1	GPs engaged in group discussion about their prescribing behaviors facilitated by peer academic detailer[62].	• Environmental restructuring • Enablement

Abbreviations: BCW = Behaviour Change Wheel; GP = general practitioner; HCA = health care assistant

DISCUSSION

Our results indicate that more than 80% of the interventions identified were complex with multi-modal approaches that comprise an average of 2.5 elements. This corroborates with past systematic reviews that also identified most interventions as being complex[63,64]. Furthermore, the intervention elements were targeted at various stakeholders. For instance, *Medication therapy management* aimed to educate patients, *training* served to equip healthcare providers with skills to improve prescribing, while *clinical decision support* provided infrastructural support. Taken together, these highlight the fact that PIP is a multi-faceted problem and multi-pronged approaches have been adopted to change the behaviours of stakeholders at the patient, healthcare provider and organization levels. *Medication review* is the most frequently adopted intervention element, much more so than *tool/instrument* and *clinical decision support*. It is likely due to the fact that PIP is a highly variable problem that varies according to the individual clinical context. The determination of medication appropriateness therefore requires not only theoretical knowledge, but also clinical judgment and experience. As such, the involvement of a pharmacist and physician in the

medication review process is crucial for sound decisions to be made to achieve optimal outcomes for patients.

On the other hand, medication reviews are often time-consuming, making them a challenge to implement in busy clinical practice[65,66]. While physicians generally appreciated support from pharmacists, some studies have also noted that the collaboration between pharmacists and physicians required trust and rapport, which would take time to develop[67,68]. Therefore, although medication review was widely adopted as a strategy to reduce PIP, a systems-oriented approach to its implementation is needed for it to function as intended. *Case Conference* and *Peer support* were found to be the least frequently adopted intervention elements. It is likely that physicians were already seeking advice from their peers when they encounter more complex cases, albeit on an informal and ad-hoc basis. Notably, 13 studies that adopted the element *Shared decision-making* were all published in the last five years i.e. 2014 to January 2019. This could be attributed to the shift in recent years towards patient-centered care, where emphasis is placed on prioritizing individual patient's needs and expectations[69]. This is particularly relevant in the context of PIP, where stopping medications can be challenging for patients, and they tend to heed the advice of healthcare professionals only if they trust the latter[70]. In order to establish trust, it is essential for healthcare professionals to consider their concerns, thoughts and expectations.

Environmental restructuring and *enablement* were the two BCW intervention functions most frequently mapped to the 14 intervention elements. *Environmental restructuring* constitutes a change in either the physical or social context[28]. This suggests that inadequate infrastructure and social support for prescribers were being addressed. *Enablement*, on the other hand, involves increasing prescribers' opportunities or capabilities to prescribe appropriately through addressing the barriers that limit their ability to prescribe optimally, such as incomplete information about patients.

Our findings will be useful in informing the development of a care intervention that will undergo feasibility testing in the second of three phases of the wider project. The anticipated product will be an effective, feasible and scalable physician-pharmacist collaborative care intervention to improve prescribing for older adults receiving outpatient care at public hospitals in Singapore.

Strengths and Limitations

We aimed to achieve methodological rigour by adhering closely to the scoping review framework proposed by Arksey & O'Malley[30] and applying the recommendations outlined by Levac *et al.*[31] and JBI[32]. A comprehensive search in both peer-reviewed and grey literature was performed and the final search strategy was developed after several rounds of iteration. We documented all search iterations attempted and systematic decisions made along the way, in order to keep an accurate record of how the eventual search strategy was finalized. Following recommendations proposed by JBI, a step-by-step protocol was developed prior to undertaking the scoping review and our research question were clearly outlined in the format of 'Population, Concept, Context'. These steps helped to provide a clear direction and focus throughout the review process. The reviewers also met frequently to clarify doubts, as recommended by Levac *et al.*

Our initial search yielded a substantial number of titles and abstracts, which could suggest that our search strategy lacked specificity. However, given the lack of standardized terms and definitions (e.g., for the concept of 'polypharmacy') available on this subject, a broad array of search terms was used to capture as many studies relevant to our research question as possible. Due to feasibility reasons, language restrictions were imposed during literature search and study selection, which could result in the omission of relevant studies and underrepresentation of available literature. A limit was also placed on the year of publication of included studies, but this was to ensure that interventions identified were relevant to current healthcare contexts. Intervention elements and functions were only coded when explicitly stated or observed. Thus, coding was limited by the extent of intervention and methodological details reported. We also did not perform the sixth stage of the Arksey and O'Malley framework i.e. the consultation exercise. This stage will be replaced by a separate Delphi study, where findings from this scoping review will be presented to a panel of clinical experts to elicit their opinions on the relevance of our findings in local prescribing contexts.

As the intention for conducting our scoping review was to mainly focus on identifying all the intervention elements that have been implemented in the outpatient settings, interactions between intervention elements within an intervention package and the effectiveness or outcomes of these interventions were not examined. It would be interesting to explore the intervention elements that are most often grouped together and the effect these elements have on one another and on the

eventual outcome in a separate work. This could provide valuable evidence on the effectiveness of separate intervention elements when combined.

CONCLUSION

This review represents the first scoping review performed to identify elements of care interventions that address PIP among older adults in the outpatient setting. The wide range of intervention elements found were characterized based on the functions they perform using the BCW intervention functions adapted from Michie *et al*[28]. The findings from this review would thus provide valuable information and guidance when designing a theory- and evidence-based complex intervention to reduce PIP. Furthermore, a theoretical framework is applied in the synthesis and analysis of data, which could be regarded as an adaptation of the scoping review methodology given that there is currently no formalized approach to data synthesis. Further investigation could involve exploring the interactions between different elements within an intervention and how they influence effectiveness in improving prescribing quality for older patients.

FIGURE LEGEND

Figure 1. PRISMA flow diagram of study selection process.

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FOOTNOTE

Contributors: KY and JQL conducted the scoping review, participated in data extraction and synthesis, and wrote the first draft of the paper for submission. JQL is the corresponding author and has taken the primary responsibility for communication with the journal during the manuscript submission, peer review and publication process, and has ensured that all the journal's administrative requirements, such as providing details of authorship, and gathering conflict of interest forms and statements, are properly completed. YYD, KTT, WA and PL provided specific content clinical expertise to inform the discussion and implications of the study results (from the perspective of geriatrician, pharmacist and researcher). YLM was the study librarian on the study and contributed to the search strategy as well as draft and review of the methods of the manuscript. All seven authors reviewed the accuracy and integrity of the work.

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Patient and public involvement: Patients and/or the public were not involved in the design, conduct, reporting, or dissemination plans of this research.

Data sharing statement: Readers interested in using our database for specific purposes related to their respective research are invited to do so by contacting the first author through their corresponding email address.

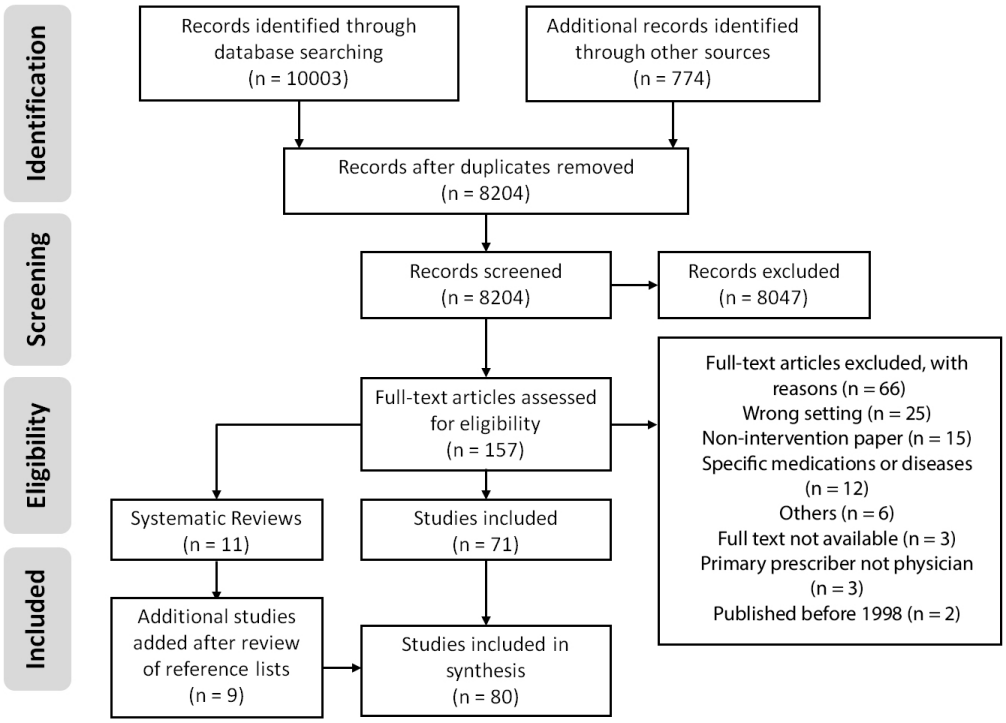

Figure 1. PRISMA flow diagram of study selection process.

225x164mm (150 x 150 DPI)

Research Question: What intervention elements *(Concept (1))* have been adopted to reduce inappropriate prescribing *(Concept (2))* among older adults *(Population (1))* with multimorbidity *(Population (2))* in outpatient care *(Context)*?					
	Population (1) **Older adults ***	Population (2) **Multimorbidity**	Concept (1) **Interventions**	Concept (2) **Reduce inappropriate prescribing**	Context **Outpatient care**
MeSH Terms	Aged	Comorbidity Multimorbidity	Medication Reconciliation Patient Care Management Case management Drug Utilization Review Guideline Adherence Decision Support Systems, Clinical	Inappropriate Prescribing Polypharmacy Potentially Inappropriate Medication List Deprescriptions Drug Prescriptions Practice Patterns, Physicians'	Ambulatory Care Outpatient Clinics, Hospital Community Health Centers Primary Health Care
Key Words	Aged Elderly Senior Seniors Older person Older persons Older people Older adult Older adults Older patient Older patients Older population Older subject Older subjects Geriatric Geriatrics	Comorbidity Multimorbidity	Intervention Interventions Implementation Strategy Strategies Behavior change technique Medication review Medication reviews Medication management Medication therapy management	Prescribing Prescription Prescriptions Medication Medications Medicine Medicines Drug prescription Drug prescriptions Inappropriate prescribing Deprescribing Physician practice pattern Physician practice patterns Clinical practice pattern Clinical practice patterns	Outpatient Ambulatory Care Clinic Clinics Primary Care Primary Healthcare General Practice

* Search terms under Population (1) were removed after several iterative searches to increase the breadth of our search. However, we specified under our eligibility criteria to include studies as long as they involved adults above the age of 65.

PubMed Search Strategy

Search ((((Comorbidity[MeSH Terms]) OR (Multimorbidity[MeSH Terms]) OR "Polypharmacy"[Mesh])) OR ((((comorbidity[Title/Abstract] OR multimorbidity[Title/Abstract] OR polypharmacy[Title/Abstract])) OR (comorbidity[Text Word] OR multimorbidity[Text Word] OR polypharmacy[Text Word]))))) AND (((((("Medication Reconciliation"[Mesh] OR "Patient Care Management"[Mesh] OR "Case Management"[Mesh] OR "Drug Utilization Review"[Mesh] OR "Guideline Adherence"[Mesh] OR "Decision Support Systems, Clinical"[Mesh])) OR ((((intervention[Title/Abstract] OR interventions[Title/Abstract] OR implementation[Title/Abstract] OR strategy[Title/Abstract] OR strategies[Title/Abstract] OR medication review[Title/Abstract] OR medication reviews[Title/Abstract] OR medication management[Title/Abstract] OR medication therapy management[Title/Abstract] OR behavior change technique[Title/Abstract])) OR (intervention[Text Word] OR interventions[Text Word] OR implementation[Text Word] OR strategy[Text Word] OR strategies[Text Word] OR medication review[Text Word] OR medication reviews[Text Word] OR medication management[Text Word] OR medication therapy management[Text Word] OR behavior change technique[Text Word]))))) AND ((("Inappropriate Prescribing"[Mesh] OR "Potentially Inappropriate Medication List"[Mesh] OR "Deprescriptions"[Mesh] OR "Drug Prescriptions"[Mesh] OR "Practice Patterns, Physicians'"[Mesh])) OR ((((prescribing[Title/Abstract] OR prescription[Title/Abstract] OR prescriptions[Title/Abstract] OR medication[Title/Abstract] OR medications[Title/Abstract] OR medicine[Title/Abstract] OR medicines[Title/Abstract] OR drug prescription[Title/Abstract] OR drug prescriptions[Title/Abstract] OR inappropriate prescribing[Title/Abstract] OR deprescribing[Title/Abstract] OR physician practice pattern[Title/Abstract] OR physician practice patterns[Title/Abstract] OR clinical practice pattern[Title/Abstract] OR clinical practice patterns[Title/Abstract])) OR (prescribing[Text Word] OR prescription[Text Word] OR prescriptions[Text Word] OR medication[Text Word] OR medications[Text Word] OR medicine[Text Word] OR medicines[Text Word] OR drug prescription[Text Word] OR drug prescriptions[Text Word] OR inappropriate prescribing[Text Word] OR deprescribing[Text Word] OR physician practice pattern[Text Word] OR physician practice patterns[Text Word] OR clinical practice pattern[Text Word] OR clinical practice patterns[Text Word]))))) AND ((("Ambulatory Care"[Mesh] OR "Outpatient Clinics, Hospital"[Mesh] OR "Community Health Centers"[Mesh] OR "Primary Health Care"[Mesh])) OR ((((Outpatient[Title/Abstract] OR Ambulatory Care[Title/Abstract] OR Clinic[Title/Abstract] OR Clinics[Title/Abstract] OR Primary Care[Title/Abstract] OR Primary Healthcare[Title/Abstract] OR General Practice[Title/Abstract])) OR (Outpatient[Text Word] OR Ambulatory Care[Text Word] OR Clinic[Title/Abstract] OR Clinics[Text Word] OR Primary Care[Text Word] OR Primary Healthcare[Text Word] OR General Practice[Text Word])))))) AND (("1998/01/01"[PDat] : "2019/12/31"[PDat]) AND English[lang])

BCW intervention function definitions and examples

Intervention Function	Definition	Example of intervention function
Education	Increasing knowledge or understanding	Providing information to promote healthy eating
Persuasion	Using communication to induce positive or negative feelings or stimulate action	Using imagery to motivate increases in physical activity
Incentivisation	Creating an expectation of reward	Using prize draws to induce attempts to stop smoking
Coercion	Creating an expectation of punishment or cost	Raising the financial cost to reduce excessive alcohol consumption
Training	Imparting skills	Advanced driver training to increase safe driving
Restriction	Using rules to reduce the opportunity to engage in the target behaviour (or to increase the target behaviour by reducing the opportunity to engage in competing behaviours)	Prohibiting sales of solvents to people under 18 to reduce use for intoxication
Environmental restructuring	Changing the physical or social context	Providing on-screen prompts for GPs to ask about smoking behaviour
Modelling	Providing an example for people to aspire to or imitate	Using TV drama scenes involving safe sex practices to increase condom use
Enablement	Increasing means/reducing barriers to increase capability (beyond education and training) or opportunity (beyond environmental restructuring)	Behavioral support for smoking cessation, medication for cognitive deficits, surgery to reduce obesity, prostheses to promote physical activity

Taken from: Michie S, Atkins L, West R. *The Behavior Change Wheel: A Guide to Designing Interventions*. London, UK: Silverback Publishing 2014.

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Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	1
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	4-5
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	5
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	NA
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	6
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	6
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	Supplementary File 2
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	5-7
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	8
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	8
Critical appraisal of individual	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe	NA

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
sources of evidence§		the methods used and how this information was used in any data synthesis (if appropriate).	
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	8
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	Figure 1
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	Table 1 (pages 9-10)
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	NA
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	9-15
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	9-15
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	15-16
Limitations	20	Discuss the limitations of the scoping review process.	17-18
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	18
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	29

JBI = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.

* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.

† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).

‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.

§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

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