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Medicine self-administration errors in the older adult population: A systematic review

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ABSTRACT

Background: Medicine self-administration errors (MSEs) are a longstanding issue in patient safety. Although many studies have examined MSEs in the general adult population, the MSEs that occur specifically in the older adult population and their contributing factors are not well understood.
Objective: To identify the types of MSEs and their contributing factors among community-dwelling older adults.
Methods: PubMed, Medline, Embase, CINAHL and Scopus were searched for primary studies published between January 1, 2014 and June 12, 2020. Studies which reported MSEs among community-dwelling older adults (≥50 years of age) and written in English were included in the review.
Results: Eleven studies met the inclusion criteria. The most commonly reported MSE was a dosing error, followed by missed dose, wrong medicine, incorrect administration methods, wrong administration time and wrong frequency. Seven of the included studies also described factors which contributed to the occurrence of MSEs. The most commonly reported factor contributing to MSEs was complex treatment regimens due to use of multiple medicines. Other factors identified included cognitive decline, decline in physical abilities, lack of social support, lack of knowledge about treatment regimens and negative attitudes and beliefs towards medicines. In most cases, MSEs occurred when multiple contributing factors were present.
Conclusion: The literature highlights a number of types of MSEs and their contributing factors which occur in the older adult population. Given that many MSEs are preventable, future research is needed into how pharmacists can support the identification and mitigation of factors contributing to MSEs in the older adult population.

Introduction

Although it has been two decades since the publication of 'To Err of Human,[1] the burden of medication errors to global health is still high. The World Health Organisation (WHO) estimates that nearly 1% of total global health expenditure (US $42 billion per year) is attributable to medication errors globally.[2] In recent years, the WHO has recognised medication safety as a global health priority in response to the long-standing issue of medication errors. In 2017 the WHO launched the "Third Global Patient Safety Challenge – Medication Without Harm" which aims to reduce severe and preventable harms resulting from medication practices by 50% within five years.[2]

The WHO defines a medication error as "any preventable event that may cause or lead to inappropriate medicine use."[3] According to this definition, medication errors may occur at any stage of the medicine use cycle, including prescribing, compounding, dispensing, distribution and administration.[3] As such, medication errors may arise when the medicine is in the control of healthcare professionals, patients or caregivers.[4] Although medication safety strategies in many Organisation for Economic Co-operation and Development (OECD) countries have primarily focused on medication errors in hospitals, the majority of errors occur in community settings. Despite this, few studies have examined issues around medication errors that occur following the self-administration of medicines in the patient's home.[5–7]

Medicine self-administration errors (MSEs) are currently a growing area of concern for the older adult population due to a significant growth in the older adult population worldwide. A recent WHO report projected that the older adult population will significantly increase by 2050,[8] with more than 20% of the global population being aged 60 years or older.[9] Another recent study predicted a two-fold increase in the proportion of older adults globally, increasing from 11% in 2000 to 22% in 2050.[10]

In addition to a growing older adult population, there is an increasing interest globally in people self-managing their healthcare.[11] Specifically, the prevalence of self-management of healthcare is

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estimated to be 54.9% in Japan, 42.5% in the US, and 40.4% in Australia.[12] However, this is not consistent across all age groups and varies across countries.[12]

Given that older adults are at risk of developing cognitive impairment and physical disabilities, their ability to independently manage their medicines decreases.[6,13] Older adults are also more likely to have multiple chronic conditions which, consequently, require numerous medicines.[14] As such, many older adults have complex medication regimens that are regularly changed.[14]

Self-medication is frequent among older adults, particularly those with a higher number of comorbidities.[15]When older adults have difficulties in accessing healthcare services, they are more likely to access medicines from supermarkets and convenience stores, without appropriate advice from a healthcare professional.[15] As more prescription medicines are down-scheduled to OTC medicines, it is likely that MSEs related to these medicines will increase due to a lack of healthcare professional consultation.[16–18]

Given the significant growth of the older adult population globally and the susceptibility of the older adult population to MSEs, it is therefore important for healthcare providers to understand the specific types of MSEs and factors contributing to these in the older adult population. Although there has been a review undertaken by Mira et al.[19] to understand the frequency, causes and consequences of MSEs that occur in the home among the general population, the review did not specifically focus on the older adult population. Therefore, this systematic review aimed to identify the specific types of MSEs and their contributing factors among the community-dwelling older adult population.

Methods

This study was conducted in accordance with guidelines from Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA).[20] The completed PRISMA Checklist is available as Supplementary File 1.

For the purpose of this review, we have defined MSEs in line with the definition of a medication administration error by Keers et al.,[21] that is, a deviation by the patients or their caregivers from the prescriber's medication orders or the manufacturer's administration instructions during the medicine administration process.

Protocol and registration

The review protocol has been registered by PROSPERO and is available under the registration number of CRD42020192343.

Eligibility criteria

Older adults were the population of this review, defined as individuals aged 50 or older.[22] A lower cut-off of 50 years was chosen to account for the variability in age definitions for older adults between countries.[22] Studies of adults of all ages were included if specific results related to older adults were clearly discernible. Self-administration of prescription or non-prescription medicines was the exposure of interest. Outcomes which met the inclusion criteria were any types of administration errors, including but not limited to, wrong medicine, wrong dose, wrong frequency and wrong administration route.[23]

Retrieved studies were excluded where the following criteria were met: if formal caregivers or healthcare professionals administered or assisted in the administration of medicines in the studies; the studies took place in institutional care settings, such as nursing homes, aged care facilities, assisted living facilities, hospital wards and other healthcare facilities; and, the studies were not primary literature, such as non-peer reviewed publications, letters to editors, commentary pieces or conference presentations.

Information sources and search strategy

A systematic literature search was performed in four online databases: PubMed, Medline (via Ovid), Embase (via Ovid), CINAHL (via EBSCOhost) and Scopus (via Elsevier). Relevant articles published from January 1, 2014 to June 12, 2020 and written in English were included. The date range was chosen to avoid replication of previous reviews of similar literature. For example, the systematic review by Mira et al.[19] included studies which were published up until November 2014. A manual search of the literature on Google Scholar was also carried out. Search terms relevant to "medication errors", "patient safety", "self-administering medication", and "older adult patients" were utilized, including any appropriate filters. The complete search strategy is available in Supplementary File 2.

Study selection

After the search was complete, all references were screened by two authors (FA and RW) independently using the Covidence systematic review online software (Veritas Health Innovation, Melbourne, Australia). The Covidence platform utilises the PRISMA systematic review process to enable reviewers to screen the abstracts and the full texts of the articles retrieved from database searches through an independent voting process. The software records any disagreements for which a final decision has to be manually agreed upon by the reviewers.

Data collection process and data items

Studies which met all inclusion criteria were included for data extraction. Data were collated by FA using a standardised form, then verified by the second author (RW). The form was designed to collect the following data: (1) author and year and publication, (2) study location, (3) study design type, (4) characteristics of study participants, (5) medicine self-administration practices, (6) resulting medication errors, (7) contributing factors of the errors and (8) additional important information.

Quality assessment of included studies

As multiple types of study designs were included in this review, the Quality Assessment Tool for Studies with Diverse Designs (QATSDD) by Sirriyeh et al.[24] was selected as the critical appraisal tool. FA performed the assessment for all included studies. To ensure the accuracy of the assessment, the second author (RW) assessed 20% of the total studies. An inter-rater reliability assessment using Cohen's kappa coefficient was conducted to measure agreement between the two reviewers.[25] An acceptable level of inter-rater reliability was pre-specified to be ranging between as 0.61–0.80, which is regarded as observing "a substantial level of agreement".[25]

Summary measures and synthesis of results

Given the heterogeneity of study types included in this review, outcomes from each study were not comparable. In addition, a completely quantitative or qualitative approach would not be appropriate. Therefore, a narrative synthesis approach was chosen for this review. This approach included identifying key findings from each study, and summarising and synthesising these to answer pre-determined research questions. Types of MSEs in this review were classified in accordance with how they were reported in the original studies. Similarly, contributing factors were collated from the original studies and were theory-based or established through direct measurement.

Results

Study selection

A total of 618 studies were obtained from the database searches and two others from manual searching on Google Scholar, as shown by the PRISMA Flow Diagram in Fig. 1. After duplicates were removed, 389 studies were subject to title and abstract screening. A total of 314 studies were excluded in the first stage of screening, primarily because the studies discussed medication errors in institutional care, or the population of interest was not limited to the older adult population. Accordingly, 75 articles were subject to full-text screening. Further, 64 were excluded, most often because the studies neither specifically focused on the older adult population nor investigated medication errors as study outcomes. Finally, 11 articles were included for qualitative synthesis.

Characteristics of included studies

There was significant variability in the older adult population included in this systematic review. As seen in Table 1, some participants were capable of self-administering their medicines, but others required assistance. One study specifically targeted frail older adult patients,[26] and one study only enrolled older adult patients recently discharged from hospital.[27] Meanwhile, three studies focused on older adults with specific diseases, including Parkinson's disease,[28] heart failure,[29] and chronic obstructive pulmonary disease (COPD) or asthma.[30]

The definition of older adults varied in the literature reviewed. Age cut-offs of 50,[27, 31] 55,[26, 32] and 65[29, 33-35] years old were all used to classify people as older adults across eight studies. Two studies did not specify an age range in their eligibility criteria, but people who were recruited in the studies were aged 50 years or older.[28,36] Although one study did not specifically focus on the older adult population, 75% of its participants were 61 years or older and reported the results in a manner where it was possible to discern specific results for the older adult population.[30] Almost all of the studies were conducted in OECD member countries, with six studies from the USA[27,29,31,32,35,36] and one study each from Australia,[26] Spain,[33] New Zealand[28] and Germany.[34] There was only one study from a lower-middle-income country (Nepal).[30]

There was one non-randomised interventional study, two cross-sectional studies, two cohort studies, two secondary analyses of data from poison centres, two descriptive studies, and two mixed-method studies included in this review. Eight studies quantitatively identified the types and factors of MSEs,[26,28,30–33,35,36] one study qualitatively identified the types and factors of MSEs[29] and two studies quantitatively identified the types of MSEs then qualitatively identified the factors.[27,34] Four studies had a large sample size of a hundred of participants or greater,[26,30,32,33] and three studies had a sample size with a less than a hundred participants.[27–29] Two pilot studies were included, one of which was a pilot for an intervention to improve medicine management during care transitions,[31] and the other a pilot for the identification of problems around medicine self-management in older patients with multiple chronic conditions and medicines.[34] Meanwhile, one study analysed 1699 telephone calls concerning medication errors to a poison centre,[35] and another study performed a secondary analysis of data from a poison centre but did not state the total number of records analysed.[36]

Quality assessment of included studies

The quality of all included studies was assessed by one reviewer and

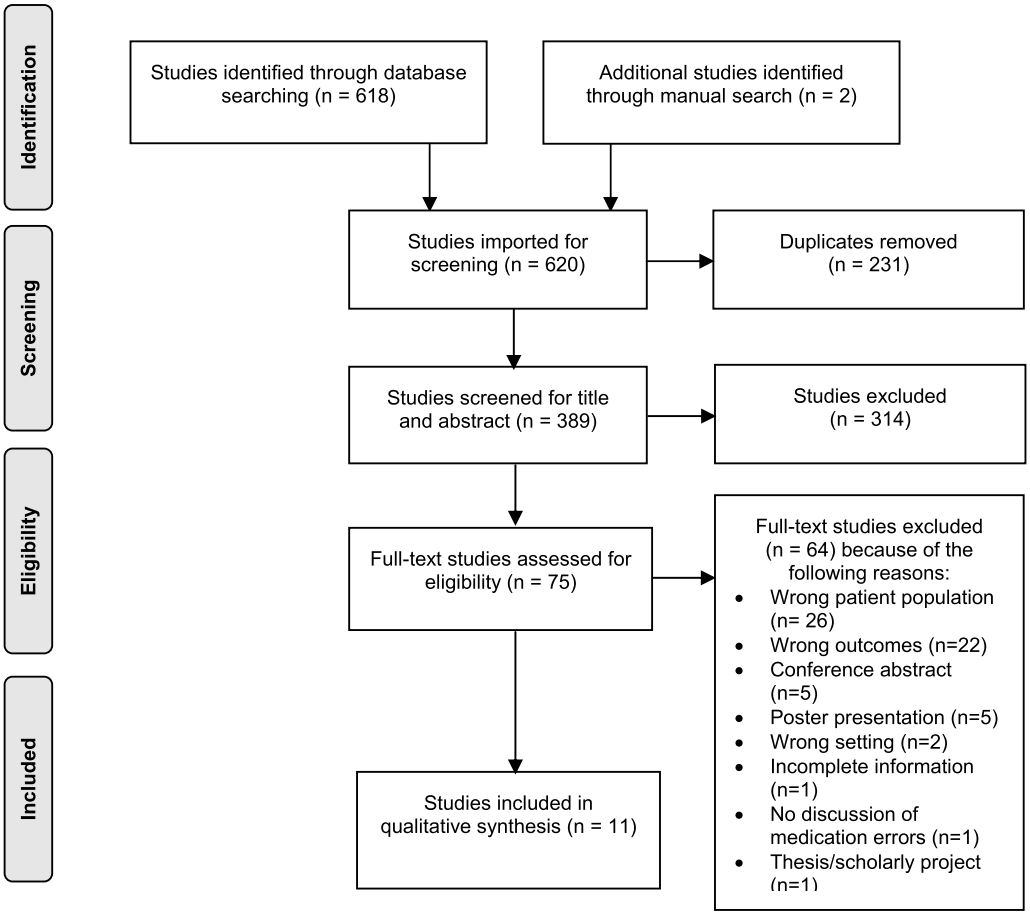

Fig. 1. Prisma flow diagram.

Table 1
Included studies and findings.

First author, year, country of study	Study design	Characteristics of study participants	Self-administering of medicines practices	Type of self-administration error	Factors contributing to self-administration errors	Additional information
Bailey et al., 2020, USA[32]	A longitudinal cohort study to investigate older patients' ability to administer multidrug regimens correctly and efficiently over a nine year follow up period and factors were predicting declines in self-management of medicines.	303 study participants completed the study. People aged 55 years or older were classified as older adults. On average, the participants were 62.6 years old at study enrolment and predominately female (72.9%). The participants were enrolled from one academic internal medicine clinic and six community health centres.	Study participants received a hypothetical, multidrug regimen, consisting of seven simulated prescription pill bottles with mock-up labels showing dosing instructions	Participants on average made 2.9 dosing errors (SD = 2.5 dosing errors; range = 0–21 dosing errors) of 21 potential errors at baseline and 5.0 errors at 9-year postbaseline (SD = 2.05 errors; range = 1–18 errors; $P < 0.001$).	Limited health literacy, cognitive decline, multiple chronic conditions and complex treatment regimens associated with the use of multiple medicines	At baseline, 16.8% of participants made at least one frequency error, 33% of them made at least one dose error, and 82.5% made at least one spacing error. At 9-year post-baseline, the distribution of errors was similar.
Elliott et al., 2016, Australia[26]	A retrospective observational study to describe the characteristics of older people referred to community nursing services for medicine management support, type of support provided, medication errors and adverse medication events.	A random sample of 100 older people referred to an extensive non-profit community nursing services in Melbourne, Australia. People aged 55 years or older were classified as older people. The median age of participants was 80 years. Commonly, participants had five different health conditions and 66% of participants used at least five medicines. 48% of the participants used at least one high-risk medicine	Use of prescription medicine at home	The missed dose was reported in 67 participants (48.9%), wrong dose in 13 participants (9.5%), consumption of wrong medicine associated with the use of dose administration aid in 12 participants (8.8%), consumption of an extra dose in 15 participants (10.9%), wrong administration method in 2 participants (1.5%), wrong route of administration in 1 participant (0.7%) and wrong dose time in 1 participant (0.7%).	Cognitive decline, physical abilities decline, poor collaboration between patients and healthcare professionals and among healthcare professionals resulting in inaccurate medicine lists, complicated treatment regimens associated with the use of multiple medicines, and confusion associated with the use of medication aids	
Knecht & Neafsey, 2017, USA[27]	A convergent parallel mixed-methods design with quantitative interviews conducted to identify medicine-taking and lifestyle behaviours of patients living with heart failure, followed by qualitative interviews to discover the patients' experience regarding their therapeutic regimens at home.	41 patients living with heart failure and recently discharged from home care following hospitalization were recruited. People aged 50 years or older were classified as older people. The age of study participants ranged from 52 to 94 years, with the mean of 81 (SD = 8) years. The mean number of medicines participant reported taking was 12.6 (SD = 5; range = 6–25)	Prescription and non-prescription medicine use at home	Patients admitted to a plethora of errors and omissions.	Difficulty in remembering complex medication regimens, lacking social support, and having negative attitudes and beliefs towards their medicines	
Kogut et al., 2014, USA[31]	A prospective nonrandomised pilot study to assess whether the identification of medication-related problems by pharmacists would be improved when patients use the ePHR system	30 study participants with a chronic medical condition completed the study. People aged 50 years or older were classified as older adults. 23 of participants (77%) were 65 years old or older, and 24 (80%) of them were hospitalised because of a cardiovascular-related illness	Use of prescribed medicines at home	Incorrect medicine use identified, including: taking albuterol inhaler once daily instead of one puff three times a day and administering sublingual nitroglycerin incorrectly	Not investigated	
Leonard & Klein-	A secondary analysis of data from a poison centre to identify the events		Not mentioned	A total of 88 study participants were identified as "pill-dumpers"	Not investigated	

(*continued on next page*)

Table 1 (*continued*)

First author, year, country of study	Study design	Characteristics of study participants	Self-administering of medicines practices	Type of self-administration error	Factors contributing to self-administration errors	Additional information
Schwartz, 2019, USA[36]	of "pill-dumping." "Pill-dumping" refers to a condition when patients combine one dose from each of their routine medicines into one "daily" vial.	The median age of pill-dumpers was 61.5 years (Interquartile range [IQR]: 54–69.75 years)		and referred to a healthcare facility because they mistakenly grabbed and took medicines from one of the stock vials and consumed a hefty dose of a single substance.		One death was reported because of the ingestion of 18 mg of colchicine.
Maya & Nona, 2018, Nepal[30]	A descriptive study to assess the technique of rotahaler inhalation among patients with chronic obstructive pulmonary disease (COPD) or asthma	101 participants, in which 88 (87.1%) of them were COPD patients and 54 (53.5%) were asthma patients. 78 (77.2%) participants aged 61–80 years. Sixty-nine patients (68.3%) were illiterate, 87 (86.1%) were chronic past smokers, and 48 (47.5%) had used rotahaler for 1–5 years.	Self-administration of rotahaler at the day of hospitalization discharge.	59 of 78 older participants (aged 61–80 years) committed administration errors. The most common mistakes were on the steps of removal of rotahaler from the mouth and holding breath for 5–10 s (53.5% participants) and exhalation to the residual volume before inhalation (49.5% participants).	Not investigated	65 (64.4%) participants reported receiving instruction about rotahaler inhalation from nurses. Errors were observed more frequently in older participants (61–80 years) compared to younger participants (41–60 years).
Mickelson & Holden, 2018, USA[29]	A descriptive qualitative content analysis of self-reported non-adherence by older patients with heart failure, in which data were collected from interviews, observations, surveys, and medical record reviews.	61 older patients from an outpatient cardiology clinic specialising in heart failure were recruited. Older patients were defined as people aged 65 years or older. The age of study participants ranged from 65 to 86 year, with a mean (SD) of 73.31 (6.73).	Self or informal carer assisted the administration of prescription and non-prescription medicines at home	A total of 35 events of unintentional errors due to slips (4 events), lapses (17 events), and mistakes (14 events) were identified. The types of errors included dose omissions, wrong time of administration, wrong medicine, wrong patient, incorrect dose, and use of expired medicine.	Lack of knowledge about treatment regimens, negative attitudes and beliefs towards medicines, cognitive decline, physical abilities decline, lack of social support, absence of error detection mechanisms, poor collaboration between patients and healthcare professionals and among healthcare professionals, complicated treatment regimens associated with the use of multiple medicines, pharmaceutical products and packaging design, and use of medication aids	Slip refers to "poor execution of the right action," e.g. intake of a wrong pill. Lapse refers to "omission of the right action", e.g. forgetting to take medicines. Mistakes refer to "the execution of the wrong action", e.g. administering the wrong dose. In most cases, errors were caused by a combination of contributing factors.
Montiel-Luque et al., 2018, Spain[33]	A cross-sectional, descriptive study to determine the prevalence of ineffective self-health management (ISHM) and its related factors in patients aged 65 years and older who were under polypharmacy and treated at multiple primary care centres in Spain.	375 participants completed the study. People aged 65 years or older were considered as older patients. The average age of the participants was 74.72 ± 5.59 years. 63.5% participants were women, 22.7% lived alone, 90.1% were from middle socioeconomic level, 19.5% were illiterate, 68.5% were functionally independent, 48.3% took more than ten medicines daily.	Use of prescription medicines at home	Medication errors were observed in 83.2% of participants. Frequency errors occurred in 62.1% participants, dose errors in 50.1% participants, omission errors in 42.4% participants and duplicity errors in 3.2% participants.	Lack of knowledge about treatment regimens, negative attitudes and beliefs towards medicines (e. g. ignorance about the pathology for which they were prescribed), cognitive decline, lack of social support and complex treatment regimens associated with the use of multiple medicines	48.3% of participants showed noncompliance according to the Morisky-Green test. 84.3% were reported storing different brands of the same medicine in their medicine cabinet. 50.1% of participants reported difficulties handling prescribed treatments.
Oad et al., 2019, New Zealand[28]	A cross-sectional self-reported online survey to investigate medicine administration practices of people living with Parkinson's disease	68 study participants were recruited. Participants aged 50–87 years old (mean = 72 years). 69% of participants were male, 76.1% were New Zealand European, 84.5% lived with the family	Use of medicines for Parkinson's disease and other diseases at home	The most common medicine administration error was the unauthorised crushing of controlled release tablets (e.g. Sinemet CR, Madopar HBS and Metoprolol CR). 30% of participants inappropriately split tablets in half, one participant sucked Metoprolol SR, and another	Absence of education regarding medicines administration and complex treatment regimens associated with the use of multiple medicines	57% of study participants experienced swallowing difficulties, most frequently with pills.

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Table 1 (*continued*)

First author, year, country of study	Study design	Characteristics of study participants	Self-administering of medicines practices	Type of self-administration error	Factors contributing to self-administration errors	Additional information
				one dissolved Madopar HBS in water		
Schenk et al., 2019, Germany[34]	A mixed-method (practical preparation task and a semi-structured interview) pilot study to identify problems in medicine self-management in older and multimorbid patients with polypharmacy	20 older patients living independently were recruited into the study after an incidence of hospitalization. Older patients referred to patients aged 65 years or older. The age of study participants ranged from 71 to 88 years, with an average of 78 years. Eight participants (40%) were male.	Self-administration of prescribed medicines at home	Study participants overestimated their medicine management skills. When their medicine preparation practices were observed, a myriad of errors as was identified. The errors included preparing and administering wrong medicines, administering the incorrect dose, crushing tablets which were not supposed to be crushed and incorrect time of administration.	Lack of knowledge about treatment regimens, multiple chronic conditions, cognitive decline, physical abilities decline, complicated treatment regimens associated with the use of multiple medicines and pharmaceutical products and packaging design (e.g. unfamiliar name of pharmaceutical products, pharmaceutical products similarity, and non-senior-friendly pharmaceutical products packaging designs)	
Willis et al., 2016, USA[35]	A descriptive epidemiologic profile of telephone calls to the Regional Poison Control Centre concerning medication errors among the elderly population in Alabama.	1699 calls were analysed, in which 78.6% were made from home. The elderly population was referred to people aged 65 years or older. The age of study participants ranged from 65 to 99 years, with a mean age of 75.2 years (+-7.4).	Consumption of prescription and non-prescription medicines.	Medication errors included taking or being given the same medicine twice, taking or being given the wrong medicine, using an incorrect dosing route, other incorrect dosing errors, and taking doses too close together.	Not investigated	Most frequently, cardiovascular medicines were involved in medication errors. The majority of medicines reported were in the forms of oral tablet and capsule.

is presented in Supplementary File 3. The quality assessment scores for the included studies varied between 12% and 71%, with a mean of 56% and a median of 62%. Two studies[30,32] (20% of the 11 included studies) were independently assessed by two reviewers (FA and RW). The resulting Cohen's kappa coefficient (κ) of 0.755 indicated a substantial level of agreement.[25]

Almost all studies explicitly mentioned a theoretical framework, their study objectives, and the research setting. However, most studies did not report any sample size considerations and did not appear to have user involvement in study design. Many studies also did not provide justification for analytical methods selected. Two studies scored lower than 50% on overall quality because of insufficient information on methodological approaches.[30,36] Nevertheless, the studies were included because they provided insightful findings.

Qualitative synthesis

1 Types of MSEs

Various types of MSEs were reported in all studies. The most frequently reported MSE was a dosing error, which was reported in seven studies.[26,29,31–35] Other MSEs reported included: missed dose,[26,27,33] wrong medicine,[29,34,35] duplicity of medicines,[33,35] incorrect preparation methods,[28,34] incorrect administration methods,[26,28,30,31] wrong administration route,[26,35] wrong administration time,[26,29,34] wrong frequency,[32,33] incorrect spacing (time period between doses),[32] and use of expired medicines.[29]

2 Factors contributing to MSEs

Seven studies reported information on the factors contributing to MSEs (Table 2). All seven studies[26–29,32–34] identified that complex treatment regimens which involved the use of multiple medicines were a contributing factor to MSEs. Four studies[26,29,32,34] identified cognitive decline as a contributing factor. Other factors identified in three studies included lack of knowledge about treatment regimens,[29,33,34] negative attitudes and beliefs towards medicines,[27,29,33] decline in physical ability,[26,29,34] and lack of social support.[27,29,33] Multiple chronic conditions,[32,34] poor collaboration between patients/healthcare professionals and among healthcare professionals,[26,29] pharmaceutical products and packaging design,[29,34] and confusion associated with the use of compliance aids[26,29] were respectively reported in two studies. Meanwhile, limited health literacy,[32] absence of error detection mechanisms,[29] and absence of patient education,[28] were reported in only one study each. It is worth noting that many MSEs occurred because of multiple interactive factors.

Discussion

To our knowledge, this is the first systematic review that specifically identified the types and factors contributing to MSEs among community-dwelling older adults. Building on the review by Mira et al.,[19] this review identified that although the older adult population shared many types and factors of MSEs with the general population, there are some MSEs specific to the older adult population, with clear implications and areas for future research to help improve medicines management in this population.

As found in this review, a key point of similarity to the general population is that dosing errors were also the most common type of MSE to occur in the older adult population.[19] Polypharmacy increases the potential for dosing errors and has previously been identified as one of the main factors contributing to MSEs in the general population.[19] This aligns with the findings of this review which found complex treatment regimens associated with the use of multiple medicines were a contributing factor of MSEs in the older adult population.

A number of important findings specific to the older adult population were identified in this review. Firstly, it was found that inappropriate splitting and crushing of sustained-release tablets was a common practice among older adult patients.[34] This finding was consistent with a study by Fodil et al.[37] which found that almost half of the medicines crushed by older adult inpatients in geriatric units were not supposed to be crushed. Modifications of dosage forms are prevalent in the older adult population as the physiological ageing process can cause difficulties in swallowing.[38] However, in this review, many older adult patients with difficulties in swallowing reported no previous education regarding how they could safely administer their medicines.[28] To prevent patient harm, older adult patients need to be informed if medicines they are taking are unsafe to crush or split.[39,40] Medicine administration strategies, such as methods to help patients swallow tablets, should also be shared with older adult patients.[41]

This review also identified that there were a number of contributing factors to MSEs which are more prominent among older adults. For example, one of the most commonly reported contributing factors to MSEs in this population was cognitive decline. This is consistent with the findings from the earlier review by Mira et al.,[19] which identified poor cognitive state as a frequent cause of MSEs. As an essential cognitive

Table 2
Summary of factors identified as contributing to MSEs[a].

Contributing factor	Study						
	Bailey et al.,2020[32]	Elliott et al., 2016[26]	Knecht & Neafsey, 2017[27]	Mickelson & Holden, 2018[29]	Montiel-Luque et al., 2018[33]	Oad et al., 2019[28]	Schenk et al., 2019[34]
Limited health literacy	x						
Lack of knowledge about treatment regimens				x	x		x
Negative attitudes and beliefs towards medicines			x	x	x		
Multiple chronic conditions	x						x
Cognitive decline	x		x	x			x
Decline in physical ability		x		x			x
Lack of social support			x	x	x		
Absence of error detection mechanisms				x			
Absence of patient education						x	
Poor collaboration between patients/healthcare professionals and among healthcare professionals		x		x			
Complex treatment regimens associated with the use of multiple medicines	x	x	x	x	x	x	x
Pharmaceutical products and packaging design				x			x
Inappropriate use or confusion associated with the use of compliance aids		x		x			

[a] Reported from 7 of the 11 studies included in the review.

function, memory plays a significant role in the planning, organisation, and execution of medicines administration. Previous studies have found that even mild cognitive impairment can result in medication errors.[42,43] Similarly, the study by Bailey et al.[32] included in this review also found that cognitive decline was a statistically significant predictor of dosing errors being made by older adults.

Older adults having negative attitudes towards medicines was also identified as a contributing factor to MSEs.[27,29,33] In this review, older adult patients who showed ignorance about their diseases and medicines were more susceptible to MSEs.[33] This finding was also observed in the study by Park et al.[44] which found that patients who were ambivalent, indifferent or sceptical about their medicines had lower medication adherence compared to those with positive attitudes. Other studies have shown that older adult patients who believe that the medicines they are taking will bring benefits to them and improve their quality of life are better able to manage their daily treatment regimens.[27]

Lack of social support was identified as another contributing factor of MSEs in older adults.[27,29,33] This review found that, when lacking social support, older adult patients were more likely to skip medicines.[27,29] The studies in this review also highlighted that social support improved older adult patients' self-efficacy in managing their medicines.[27] The findings were supported by DiMatteo,[45] who found that social support was positively associated with medication adherence. Notably, older adult patients in this review, particularly those who lived alone, often reported being overwhelmed with complex treatment regimens.[27]

Although compliance aids are often used to support older adult patients with complex treatment regimens, they were also identified as a contributing factor to MSEs.[26,29] For example, an older adult patient mistakenly put two look-a-like medicines into the wrong compartment when filling her pillbox.[29] The patient was unaware of the error until several days later when she felt unusually fatigued and subsequently checked the pillbox.[29] This was similarly observed in a study investigating community-dwelling older adults' ability to understand and implement a routine prescription medication which found that 22% of older adult patients failed to fill their pillbox correctly.[46] Several studies have supported the use of compliance aids,[47–49] such as pillboxes, dose administration aids (DAA) and multicompartment compliance aids (MCA), to improve compliance and reduce medication errors. This review also found compliance aids useful as error detection mechanisms since patients will be aware if they miss earlier doses at the next scheduled dosing time.[29] However, compliance aids can also result in MSEs when being used by patients with impaired dexterity, or those with visual or cognitive impairment who often encounter difficulty in filling their compliance aids.[50]

Additionally, MSEs could occur as the result of a decline in physical abilities.[26,29,34] For example, the sensory and grip strength skills of some older adult patients in this review were inadequate to open the packaging of medicines conveniently.[34] Consequently, the patients applied a powerful force to push out the tablets, causing the tablets to pop out and fall into the wrong compartment of the MCA.[34] A similar incident was reported in the study of Souza and Santana.[51] Older adult patients in the study reported tremor, weak handgrip and decreased hand strength.[51] The study identified that patients emptied the pillbox into their palm, a table or a counter to overcome the difficulty of picking a pill.[51] This means that the chances of MSEs are heightened among people using a pillbox which has only one lid to cover all compartments.[51]

Although socio-cultural factors were not identified as contributing factors of MSEs in this review, older adult patients who were part of culturally and linguistically diverse populations (CALD), including ethnic minority groups, have been identified in the literature as having a higher risk of medicine mismanagement compared to the majority population.[52,53] A previous study has identified older adult patients from CALD populations lacked knowledge about medicines and changes to their medicines.[54] The study highlighted that health practitioners sometimes assume that an interpreter is not required, which contributes to the low rate of interpreter engagement when communicating with patients from CALD backgrounds.[54] In contrast, another study demonstrated that despite providing medicine counselling in a patient's native language, the patient still demonstrated a poor understanding of the usage directions of their medicines.[55] Given an increasing trend of mass migration globally,[56] it is important that health professionals not only consider the use of interpreter services, but also address potential socio-cultural factors in an attempt to reduce MSEs among older adult patients.

Implications

This study has identified that both complex treatment regimens and cognitive decline are the most commonly reported factors contributing to MSEs among older adults. To date, there have been a number of strategies employed by pharmacists to mitigate these two factors. Most commonly, these have been managed by various types of medication reviews to rationalise the use of medicines, followed by recommendations for patients to commence using a compliance aid. However, these proposed solutions have limitations. Medication reviews, particularly which are performed in pharmacy settings, may not necessarily investigate self-medication practices and may fail to identify potential errors from the use of non-prescription medicines. Whilst home medication reviews may be one solution to this problem, they are not necessarily common practice, particularly in developing countries. Additionally, this study has identified that some MSEs in older adult patients occurred due to the patient's confusion with how to use their compliance aids.

Furthermore, it is important to note that there are various factors which can contribute to MSEs in older adult patients, such as lack of knowledge, negative attitudes and beliefs towards medicines, physical ability decline and lack of social support. Accordingly, there is no single solution to prevent MSEs, with piecemeal approaches not holistically addressing all patients' needs. As such, future research needs to focus on how pharmacists can better support older adult patients in self-managing their medicines, particularly as more older adults are choosing to live independently for longer. Future research should consider the development of a decision support framework to assist pharmacists who undertake medication reviews. Ideally, the decision support framework should incorporate a screening tool to assess patients' physical and cognitive abilities, social support networks, and resources to help pharmacists better support older adult patients in their abilities to self-manage their medicines. A more generic framework could be initially developed and subsequently tailored to each country's needs through stakeholder engagement. The development of this framework may not only improve the quality of life of older adult patient's and the care delivered by their caregivers, but it will also enable pharmacists to deliver higher quality care tailored to the patient's needs. It also would have the potential to enable better management of patients by their medical practitioners, as well as potentially reduce the cost to health systems from reduced hospitalisations related to MSEs.

Limitations

This review had a few limitations. Firstly, only studies written in English were included in this review. The systematic search was also performed in only four online databases. Consequently, this review might have missed relevant information from unpublished studies, published studies written in other languages, and studies published in journals which were not indexed in the searched databases. Furthermore, given the heterogeneity of the included studies, results from individual studies could not be pooled and a narrative synthesis approach was required.

Conclusion

This review has identified a number of MSEs and contributing factors to MSEs specific to the older adult population. Given the variety of types

of errors and multiple factors contributing to these, pharmacists have the potential to play a pivotal role in identifying potential contributing factors to MSEs and putting in place mitigation strategies to prevent harm in this vulnerable population.

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Declaration of competing interest

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Appendix A. Supplementary data

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