Intended for healthcare professionals

Sage Journals

Journal of Multimorbidity and Comorbidity

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Abstract

Background

Older adults with multimorbidity experience fragmentation of care. Ensuring optimal use of healthcare services requires stratifying their need for integrated care. We aimed to map existing stratification tools for assessing older adults with multimorbidity in an integrated care context.

Methods

We searched MEDLINE, Embase, PsycINFO, Cochrane Library, and CINAHL, and extracted definitions of population, concept, and context following the JBI Framework for Scoping Reviews.

Results

We identified 17,689 articles of which 11 articles were included. Few stratification tools for this population exist and differ on scoring methods, domains and settings of use. Stratification is used for identifying older adults with multimorbidity to multidisciplinary teams or to case managers. Future research should develop stratification tools across sectors focused on the common risk factors of multimorbidity in older adults.

Background

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The global prevalence of multimorbidity—defined as the co-occurrence of multiple chronic diseases—is rising[1,2] and is associated with increased use of healthcare resources and polypharmacy.[2,3] Increasingly common with older age, multimorbidity is highly heterogeneous due to differences in the diseases present and their severity, often visualised by disease clusters with similar aetiology.[2,4,5] Complex multimorbidity is often defined as a severe form of multimorbidity,[6] reflected in differences in prognosis and improvements following healthcare interventions. For example, life expectancy in older adults with mental–physical multimorbidity is 10–20 years shorter compared to the general population.[7–9] In addition, extremely poor health-related quality of life is observed in older adults with complex cardiometabolic and respiratory disease clusters.[10] Healthcare use, length of stay, and bed rest days increase linearly with the number of chronic conditions,[3] further adding to the complexity of multimorbidity in older adults.

Treatment of multimorbidity remains fragmented, despite emerging knowledge about disease clusters. Older adults experience higher rates of care transitions across healthcare sectors,[11] influenced by factors such as educational attainment and poor health literacy.[12–14] Mortality in older adults with multimorbidity also exhibits an occupational gradient, with lower socioeconomic status associated with a greater 10-year mortality risk.[15] This complex interplay between biological, psychological, and sociological factors necessitates integrated care approaches that ensure all aspects of treatment are incorporated into an individualised and patient-centred plan.[16]

Integrated care refers to care models that adopt a holistic approach to treatment, often comprising flexible, person-centred care plans with an emphasis on coordi... collaboration between healthcare professionals and across healthcare sectors.[17] However, definitions of integrated care vary between healthcare systems and also lack a standardised measure for integrated care quality.[18] Providing integrated care requires the allocation of time and resources that extends beyond usual care and demands precise identification of older adults with the greatest need for integrated care.[16]

As a result, there is a growing demand for effective tools capable of identifying the need for integrated care among older adults with multimorbidity, with the aim of improving care and health outcomes through integrated care approaches. However, it remains unknown which stratification tools are available for identifying the need for integrated care in older adults with multimorbidity, and whether such tools are used within an integrated care context. Therefore, the aim of this scoping review is to map the existing literature on stratification tools for older adults with multimorbidity in an integrated care context.

Methods

Protocol and registration

Development of the protocol was informed using the Joanna Briggs Institute Guidelines[19] and reported using the PRISMA Guidelines for Scoping Reviews.[20] The protocol was made publicly available at the Open Science Framework Registry (https://doi.org/10.17605/OSF.IO/8H3DT).

Consultation with knowledge users

We conducted consultations with knowledge users during the development of the review, following the guidelines by Pollock and colleagues (2022) to ensure the clinical relevance of the scoping review. In short, consultation exercises with knowledge users refer to the ways in which they may be involved in conducting systematic and scoping reviews.[21]

We recruited knowledge users through gatekeepers in hospitals and primary care settings. Knowledge users were selected on the basis that each represented an area of knowledge and expertise within and across the healthcare system. The JBI four-stage guidance[19] was used to prepare for the involvement of knowledge users. Consultations employed participatory design through interviews and workshops. We consulted multiple knowledge users before, during, and after the review process. Knowledge users included healthcare professionals from psychiatric and somatic departments across Næstved-Slagelse-Ringsted Hospitals (n = 7), general practitioners (n = 2), healthcare professionals from the municipality (n = 8), one patient with multimorbidity and their relative in a patient organi[sation] and researchers (the authors of this article). Knowledge users participated in workshops that informed the authors about the need for stratification tools and the description of the population, concept, and context. We used this information to define our eligibility criteria and ensure the relevance of our aim.

Eligibility criteria

We included papers that met the following criteria: (a) older adults aged ≥65 years with multimorbidity (defined as two or more chronic conditions); (b) use of stratification tools to stratify participants; and (c) use and/or development of a stratification tool to provide integrated care, defined as collaboration or coordination between two or more sectors of healthcare (e.g. hospital departments, general practices, municipalities) (Table 1). We

included only peer-reviewed articles and excluded those not written in English, Danish, Norwegian, or Swedish.

Table 1. Eligibility criteria used in selection of evidence.

Population, concept, context (PCC)	Description
Population: Older adult(s) ≥ 65 years with multimorbidity	Definition(s): Two or more chronic conditions (either defined as counts or described). Chronic conditions include both physical and mental conditions
Concept: Stratification tool(s)	Definition(s): A stratification tool is defined as a tool that is validated and evaluated to distribute, select, and prioritize older adults in relation to a specific clinical outcome (e.g., risk of hospital remittance, mortality risk, healthcare utilization)
Context: Integrated care	Definition(s): Integrated care – through cross-sectoral collaboration and coordination – between two (or more) sectors (e.g., hospital departments, general practices, municipalities)

Search strategy

We conducted a systematic search in Embase, MEDLINE, Cochrane Library, PsycINFO, and CINAHL from January 2007 to May 2025. This period was chosen to ensure that the available literature was up to date. One author (VZ) evaluated the initial search strategy in PsycINFO, MEDLINE and Embase. The search matrix included subject indexing terms and free-text terms for title, abstract, and keyword searching. One author (VZ) conducted the initial search in collaboration with a research librarian. We extracted and imported all articles into EndNote X8 for data management and later into Covidence (https://www.covidence.org) for screening. Covidence automatically removed any remaining duplicates. Search matrices and search results can be found as Supplemental Material for all databases.

Selection of sources of evidence

Four authors (JAC, MM, DH, LB) pilot-tested the eligibility criteria on 50 articles. Two authors (JAC, MM) independently screened titles, abstracts, and full-text articles in accordance with our pre-specified eligibility criteria. Any conflicts were resolved by two senior authors (DH, LB). We adjusted our eligibility criteria following the initial screening, as recommended in the literature.[19,22,23]

Data charting process

All authors reviewed and updated the data extraction form through an iterative process. JAC and MM independently extracted data from the included articles. Inconsistencies in data extraction were resolved through consensus discussions held in online meetings between the two authors (JAC and MM).

Data items

We extracted data on study characteristics (e.g. title, authors, year, and country); characteristics of the included articles (e.g. study aim, design, study setting/context); participant characteristics (description of the population, eligibility criteria, type of recruitment method, total number of participants, male-to-female sex ratio, and chronic diseases); outcome characteristics (description of stratification tools and assessment methods, description of primary and secondary outcomes); and any reported adverse events. We mapped the key findings of the included articles and presented them narratively.

Results

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Selection of sources of evidence

We identified 21,345 articles. After removing duplicates, we screened 17,698 articles and selected 69 for full-text review. Eleven articles met the eligibility criteria for inclusion in our analysis (Figure 1). Articles were excluded for the following reasons: no use of stratification tools to identify population of interest (n=8); patients not being older adults with multimorbidity (n=15); stratification not conducted in an integrated care context (n=11); language other than English, Danish, Swedish and/or Norwegian (n=3), and source not a peer-reviewed study (n=21).
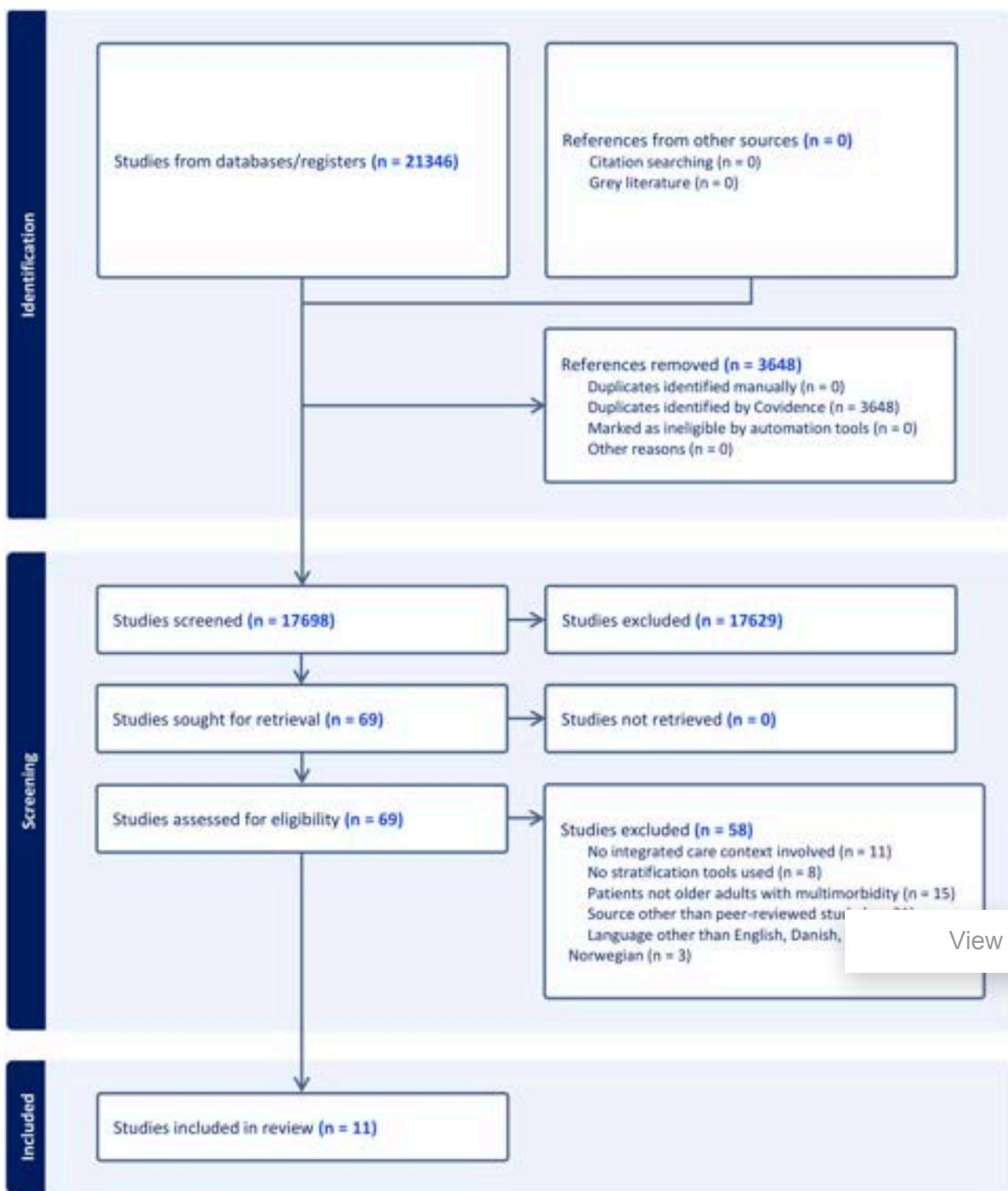
Figure 1. PRISMA flowchart of selection process.

Characteristics of sources of evidence

We included randomised controlled trials (n = 4), a case study (n = 1), a qualitative action
research study (n = 1), a quasi-experimental study (n = 1), an observational retrospective

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study (n = 1), a feasibility study (n = 1), and cohort studies (n = 2). The articles included a total of 26,689 participants, of whom 16,053 were female (60.1%). The age range was between 60 and 89 years, with a mean age of 80.4 years. Articles were published between 2015 and 2023 and were conducted in Australia (n = 2), the United Kingdom (n = 3), the Netherlands (n = 1), Sweden (n = 1), Germany (n = 1), Spain (n = 1), the USA (n = 1), and the Basque Country (n = 1). (Table 2)

Table 2. Characteristics of included studies.

Author, year	Country	Study aim	Study design	Population	Stratification tool(s)
Arendts et al., 2018	Australia	Measure the effects of a care-coordinated intervention on readmission to hospital emergency departments among patients stratified as "high risk" using a risk nomogram	RCT	Patients aged ≥65 years discharged from emergency departments, identified as "high risk"[a] for readmission. Patients were not explicitly defined as multimorbid but had a median of 11 chronic conditions (IQR 9–16), while the control group had a median of 10 chronic conditions (IQR 8–16). The types of conditions	Screening was conducted by research nurses using a computerised version of a risk tool was used to identify high-risk patients, defined as having a 30% probability of readmission to the emergency department within 28 days following discharge. At-risk patients were selected for a patient-centred intervention

Author, year	Country	Study aim	Study design	Population	Stratification tool(s)
				were not reported	
Birch et al., 2016	United Kingdom	To demonstrate how hospital admission was avoided and patient health outcomes improved by providing a nurse-led, systematic approach to the assessment and treatment of a complex geriatric patient	Case study	Female patient, aged 89, with complex health and social care needs[d]. The patient was not explicitly defined as multimorbid but had a medical history of multiple comorbidities, including previous stroke, hypertension, osteoarthritis, ischaemic heart disease, atrial fibrillation, and constipation. Active medication induced orthostatic hypotension and delirium	The Comprehensive Geriatric Assessment (CGA) was conducted by a nurse. The CGA identified issues related to delirium, hypotension, polypharmacy, fall risk, and social and safety concerns
Blom et al., 2016	Netherlands	To assess the effectiveness and cost-effectiveness of a	RCT	Community-dwelling older adults aged ≥75 years.	The ISCOPE screening questionnaire was sent by ma

Author, year	Country	Study aim	Study design	Population	Stratification tool(s)
		structured monitoring system to detect deterioration in somatic, functional, mental, or social health, and to follow up with a combined care plan		Participants were not explicitly defined as multimorbid but had a median of two chronic conditions across all groups (non-complex, complex, and non-responders)	and included GARS, Groningen activity restriction scale; BADL, basic activities of daily living; IADL, instrumental activities of daily living; MMSE, mini mental state examination; GDS, Geriatric depression scale; DJG, De Jong-Gierveld loneliness scale. The combined score of the GARS, GDS, and DJG scores, along with self-reported health was used to identify complex versus non-complex participants
Jones et al., 2023	United Kingdom	To assess the impact of a new GP-led modified Comprehensive Geriatric	Observational retrospective study	Patients identified as moderately to severely frail using the	GP-led modified Comprehensive Geriatric Assessment (CGA) conducted

Author, year	Country	Study aim	Study design	Population	Stratification tool(s)
		Assessment (CGA) on service delivery, healthcare utilisation, and patient outcomes in patients with moderate to severe frailty		Electronic Frailty Index (eFI). Those with a frailty score above 0.24 were included. Patients were not explicitly defined as multimorbid, but the total number of chronic conditions was 3–4. Enrolment into either the MidMed intervention or control group was determined by the MidMed GP based on practicality	by the general practitioner. Dimensions of stratification included physical, functional, social, psychological, and medication related factors
Mazya et al., 2019	Sweden	To analyse the effect of outpatient CGA on frailty among community-dwelling older adults with multimorbidity and high healthcare utilisation	RCT	Community-dwelling older adults aged ≥75 years who had been hospitalised three or more times in the previous year and had three or more current medical	The assessment was conducted by a nurse or an occupational therapist involved in the care of each patient, while a pharmacist collected information on drug

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Author, year	Country	Study aim	Study design	Population	Stratification tool(s)
				diagnoses according to ICD-10	prescriptions and medication use via telephone. Frail was measured using the criteri from the cardiovascular health study. Weakness was assessed using hand dynamometry; depression usin the Centre for Epidemiologic Studies Depression Sca (CES-D) wit metres; and activity levels using the International Physical Activity Questionnaire - Short Form (IPAQ-SF). Participants we then classified a robust (no frailt criteria fulfilled) pre-frail (1–2 criteria), or frail (≥3 criteria), regardless of

Author, year	Country	Study aim	Study design	Population	Stratification tool(s)
					missing data. This classificatio was used as par of the initial CG. based evaluatic
Meyer et al., 2022	Germany	To investigate the impact of a Tailored Intersectoral Discharge Programme (TDIP) on multidimensional frailty, rehospitalisation days, and patient-related outcome measures in older in-patients undergoing acute care and standard rehabilitative care	RCT	Patients aged ≥60 years affected by multimorbidity (defined as the co-occurrence of two or more chronic or acute diseases and medical conditions requiring treatment), who were admitted for the treatment of an acute illness and were suffering from at least two geriatric syndromes requiring rehabilitative care	All patients wer assessed on admission usin; the Comprehensive Geriatric Assessment-based Multidimension Prognostic Inde (CGA-MPI), whic stratify patients into frailty risk groups (MPI-1: Robust and low risk, MPI-2: prefrail and moderate risk, and MPI-3: frail and severe risk)
Molist-Brunet al., 22	Spain	To characterise a cohort of older adults with multimorbidity,	Quasi-experimental design	Participants were older adults over the age of 65 with	The PCP model included a Comprehensive Geriatric

Author, year	Country	Study aim	Study design	Population	Stratification tool(s)
		calculate their frailty index, and conduct a medication review through the application of the Patient-Centred Prescription (PCP) model		multimorbidity, identified by their general practitioners as having difficulties with prescription management and a need for a multidisciplinary medication review	Assessment (CGA) to identify patients, along with a diagnosis centred and medication-centred assessment. The results of the CGA, including the frailty index score, were used to inform the development of a therapeutic care plan
Mount et al., 2015	United States	To determine the characteristics of contextual factors contributing to the complexity of patient care in primary care	Action research	Participants were older adults attending consultations in primary care. Although multimorbidity was not explicitly defined, both groups of participants had between 5.08 and 10.61 conditions	A 13-item using an action research approach, which involved structured group discussions with self-identified complex patients, healthcare professionals, and researchers. These discussions focused on constructing a

Author, year	Country	Study aim	Study design	Population	Stratification tool(s)
					shared understanding 'patient complexity' to assess the complexity of care for older adults. Case descriptions were thematically analysed and synthesised into the assessment tool
Mudge et al, 2016	Australia	To examine the impact of the THRIVE model on medication count, tablet load, and the use of potentially inappropriate medicines (PIMs)	Feasibility study	Participants were in-patients aged 60 and older who had experienced at least one unplanned hospitalisation within the previous six months. The median charlson comorbidity score was 3 (IQR: 1–4), indicating a population with multimorbidity. Patients commonly	The Screening Tool of Older (STOPP) was used to identify potentially inappropriate medicines, alongside a qualitative comprehensive assessment

Author, year	Country	Study aim	Study design	Population	Stratification tool(s)
				presented with symptomatic comorbidities, including osteoporosis (n=9), venous thromboembolic disease and chronic venous insufficiency (n=5), mental health disorders (n=7), chronic back pain (n=5), and painful peripheral neuropathies (n=6)	
Soto-Gordoa et al., 2019	Basque Country	To assess the effectiveness of a population-level, patient-centred intervention for patients with multimorbidity aged over 65 years, using risk stratification	Cohort study	Participants included all individuals over the age of 65 with multimorbidity in the Basque Country. Multimorbidity was defined as the presence of at least two out of three chronic conditions—diabetes mellitus, heart	A risk score predicting healthcare resource consumption over the following year, compared with the general population, was used to stratify patients. This score was based on the Adjusted Clinical Groups (ACG) system,

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Author, year	Country	Study aim	Study design	Population	Stratification tool(s)
				failure, and chronic obstructive pulmonary disease—identified using ICD-9 codes	which measures the burden of multimorbidity patient populations by analysing disease pattern age, and gender using diagnostic and pharmaceutical data from administrative databases. Patients were prioritised if they had been hospitalised in the top five percentiles of the stratification pyramid
Parry et al., 2023	United Kingdom	To determine how a proactive digital healthcare system can be used to conduct a comprehensive needs analysis of patients at risk of unplanned admission and mortality. The	Cohort study	Participants included adults aged 18 years and older[f], recruited from general practices in a deprived, multi-ethnic area of the UK. The majority of	Stratification wa conducted in tw stages to identi unmet needs. In the first stage, patients were categorised as either "escalate or "non-escalated" using data-driven risk

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Author, year	Country	Study aim	Study design	Population	Stratification tool(s)
		study was designed as a cohort study		patients had three or more comorbidities across all groups (over 84%), involving the 16 most common long-term chronic conditions. Most patients were found to have unmet needs across four domains during the stratification process	stratification based on seven risk factors from the Wolverhampton integrated Clinical data set. Patients in the escalated group underwent a rapid clinical assessment by a general practitioner and were further triaged into "concern" and "no concern" categories. The stratification relied on the clinical judgement of the GP. For patients in the concern category, the GP conducted an unmet needs Analysis and determined the appropriate course of action including referral for multidisciplinary

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Author, year	Country	Study aim	Study design	Population	Stratification tool(s)
					team (MDT) review

[a]High risk was defined as having a 30% probability of readmission to the emergency department within 28 days following discharge.

[b]The risk nomogram used was a previously validated tool developed by Arendts and colleagues in 2015 (doi: 10.1007/s11739-015-1219-3).

[c]The number of female participants (counts and percentages) was extracted and calculated from tables within the articles.

[d]Complex social needs were not defined in the study.

[e]The study was included based on the complex group meeting the mean age inclusion criteria.

[f]The mean age in all groups was ≥65 years, and the study was therefore included in our analysis.

Synthesis of results

All articles used stratification tools for assessing the need for integrated care, but differed in the specific tools employed. For example, a validated risk-prediction nomogram was used to predict emergency department readmission.[24] Risk nomograms are tools used to assess the likelihood of specific clinical outcomes (e.g., mortality, readmission, falls), and have been extensively applied to differentiate and prioritise individuals during treatment and interventional work. The Comprehensive Geriatric Assessment (CGA) was widely used in multiple studies to provide a comprehensive evaluation of risk factors and treatment needs, though the scoring methods, assessment domains, and settings of use varied across the

included studies.[25–27] The CGA is a common multidimensional screening tool for assessment of geriatric patients.[28,29] One study included a comprehensive assessment of patients across domains such as function, nutrition, and medical history, but did not explicitly define this approach as CGA,[30] while another study used the CGA as one component of a broader assessment procedure.[31] The Adjusted Clinical Groups (ACG) system was used in a single study,[32] while others varied in the domains assessed and the scoring methods applied.[33–35] Not all scoring methods were clearly described. Stratification was primarily conducted either in hospital or clinic settings (n=6), or in general practice (n=5).

All participants were older adults with multimorbidity but differed in their medical histories and comorbidities. Interestingly, most participants were not explicitly defined as multimorbid but were often characterized as 'frail', 'geriatric' or 'complex'. The mean age across most groups was >75 years, with the highest being 89.0 years,[25] indicating a very old population. Patients were most often recruited from hospitals or general practices, as recruitment to integrated care involved assessing and stratifying patients on their risk of a clinical outcome and/or treatment needs.

The integrated care context to which patients were stratified varied widely across studies. Stratification was often used to identify the need for multidisciplinary teams to collaborate on and coordinate treatment and care plans,[25–27,30,32,33,35] as well as the need for a care manager to help coordinate referrals and act as the primary contact across sectors.[24,36] One study developed the stratification tool specifically within an integrated care context to test the construct validity of identifying complex versus non-complex older adults with multimorbidity in primary care.[34] (Table 3)

Table 3. Characteristics of included stratification tools.

| Author, year | Stratification tool name | Properties | | Setting of use |
		Measurement item(s)	Scoring method(s)	
Arendts et al., 2018	N/A	Number of prior registrations (0-11) Age (60-110 years) Male (no: 0 | yes: 1) Polypharmacy (no: 0	Risk nomogram	Hospital/clinic

| Author, year | Stratification tool name | Properties | | Setting of use |
		Measurement item(s)	Scoring method(s)	
		| yes: 1) Cognition SIS (0-6) Malignancy (no: 0 | yes: 1) CCT intervention (no: 0 | yes: 1) Depression (no: 0 | yes: 1)		
Birch et al., 2016	Comprehensive Geriatric Assessment	Multicomponent assessment of medical, cognitive, psychological, functional and social components using validated questionnaires and tests	Not described	Hospital/clinic
Blom et al., 2016	ISCOPE screening Questionnaire	Questionnaire consisting of four domains: functional, somatic (health and illness), mental and social. Each domain had 4-9 questions	Positive answers to two or more questions in a domain lead to a positive score on the domain. Items are derived from existing validated questionnaires, and are based on predictors related to functional decline	General practice
Jones et al., 2023	Comprehensive Geriatric Assessment Toolkit for Primary Care Practitioners	Multicomponent assessment of physical, functional, social, psychological and medication domains. Based on	Not described	General practice

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Author, year	Stratification tool name	Properties		Setting of use
		Measurement item(s)	Scoring method(s)	
		this, a problem list was generated		
Mazya et al., 2019	Comprehensive Geriatric Assessment	Multicomponent assessment survey on health, functional status and need for social care. Information on compliance with prescribed and non-prescribed drugs was also used	Not described	Hospital/clinic
Meyer et al., 2022	Comprehensive Geriatric Assessment-based multidimensional Prognostic Index (MPI)	Mathematical algorithm based on 8 domains including daily functions, cognitive performance, malnutrition, social status, multimorbidity, polypharmacy, and decubitus risk	Continuous risk score from 0 to 1 allowing allocation to 1 of 3 frailty and poor outcome risk grades: MPI-1: 0-0.33 = robust and low risk MPI-2: 0.34-0.66: Prefrail and moderate risk MPI-3: 0.67-1: Frail and severe risk	Hospital/clinic
Molist-Brunet et al., 2022	Patient-centered Prescription model (PCP model)	Three-step assessment model to develop a therapeutic plan: Patient-centered assessment using the Comprehensive Geriatric Assessment, diagnosis-centered Assessment by	Not described	General practice

Author, year	Stratification tool name	Properties		Setting of use
		Measurement item(s)	Scoring method(s)	
		looking for coherence between medication objectives and patient goals, and medication-centered assessment by assessing the indication of high risk of adverse events		
Mount et al., 2015	Complexity screening Tool	Sections-based screening questionnaire. The first section includes two questions related to what adverse impact on their practice led the GPs to consider the patient as having complex care needs. The second section includes 13 brief statements that describe risk factors for complexity	The first section is a binary assessment (YES/NO). The second section requires 13 questions to be ranked, where 1 = most important	General practice
Mudge et al, 2016	N/A	Structured comprehensive assessment of patient goals, support, function, nutrition, mood, medical history and active morbidities	Not described	Hospital/clinic

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| Author, year | Stratification tool name | Properties | | Setting of use |
		Measurement item(s)	Scoring method(s)	
Soto-Gordoa et al., 2019	Adjusted Clinical Groups (ACG)	The ACG measures the morbidity burden based on disease patterns, age and gender. It relied on diagnostic and pharmaceutical information to assign an individual risk score predicting healthcare resource consumption	Not described	Hospital/clinic
Parry et al., 2023	N/A	Two stages of stratification. First stage stratified patients to 'escalated' versus 'non-escalated'. The second stage included a rapid clinical assessment of the general practitioner to triage patients to 'concern' and 'no-concern'	First stage used data-driven stratification based on seven risk factors from registries: ≥ 3 accident and emergency (A&E) admissions over the prior 12 months not leading to an NEA ≥ 3 non-elective admissions (NEA) over the previous 12 months; the 30-day emergency admissions predictor PARR score at a threshold value of 80%[9]; ≥ 3 co-morbidities; the electronic frailty index (EFI) moderate or severe classification, nursing home residency and end of life registration. The second stage relied on	General practice

| Author, year | Stratification tool name | Properties | | Setting of use |
		Measurement item(s)	Scoring method(s)	
			the general practitioner's judgement to stratify groups	

Discussion

To our knowledge, this is the first scoping review to map the existing literature on stratification tools for older adults with multimorbidity in an integrated care context. Despite a large number of articles, we identified 11 studies that stratified older adults with multimorbidity within such a context. The tools identified often involved comprehensive assessments of physical, psychological, or social dimensions of health, and frequently incorporated widely used instruments—such as the Comprehensive Geriatric Assessment (CGA)—to identify appropriate patients and determine their need for integrated care approaches. However, the tools varied considerably in terms of the assessment domains included and the scoring methods used for stratification, combining objective measures, questionnaires, and qualitative assessment methods. All studies included participants characterised by multimorbidity, although not all explicitly defined their populations as such. In most cases, stratification was used to identify the need for a multidisciplinary [team to] collaborate on treatment planning, or to determine the need for a case manager responsible for coordinating referrals and serving as the patient's primary point of contact.

Stratification tools must be used to differentiate subpopulations into strata based on the risk of a particular outcome occurring, and represent a valid method for guiding treatment decisions.[37] Our results show that, while stratification tools are employed to identify patients for integrated care approaches, the properties, domains, and scoring systems used are largely heterogeneous across studies. Indeed, considerable variability in the risk factors included for stratification is common when attempting to identify patients with multimorbidity, making it difficult to draw generalised conclusions or make comparisons across tools.[38] The heterogeneity in both stratification domains and outcomes may be [attri]buted to the lack of consensus on a meaningful definition of multimorbidity, particularly [re]garding which risk factors are most relevant when identifying older adults at highest risk of

adverse clinical outcomes.[39,40] Although efforts have been made to refine the concept of multimorbidity—such as through the introduction of terms like complex multimorbidity and mental–physical multimorbidity—these approaches have not yet proven effective in identifying the key risk factors needed for stratification.[6]

Most of the included studies used the Comprehensive Geriatric Assessment (CGA) to assess patients. While the CGA has been validated across various settings in older adults, it has not been externally validated specifically for older adults with multimorbidity. This omission may result in important risk factors being overlooked when stratifying this population, potentially contributing to poor quality of life and increased mortality risk. More broadly, many new models are rarely externally validated and often lack clinical utility.[41] It may be argued that, given the high prevalence of multimorbidity among older adults, the use of tools such as the CGA to identify their needs is unproblematic. However, multimorbidity is highly heterogeneous across age groups due to differences in disease clusters and socioeconomic status.[4,12] This suggests that the risk factors relevant for determining the need for integrated care—and therefore those that clinicians should stratify on—vary significantly even within seemingly similar populations, such as older adults. The absence of a meaningful definition for differentiating risk profiles in older adults with multimorbidity may explain why no tools identified in this review were specifically developed and validated for this population. Instead, most tools adopt a comprehensive and holistic approach, incorporating multiple domains to identify appropriate patients for integrated care. This highlights a persistent knowledge gap in the development and validation of stratification tools tailored to older adults with multimorbidity in integrated care contexts.

The heterogeneity of sample populations, outcome measures, and risk factors not only complicates comparisons across stratification tools but also presents a significant challenge to their implementation within broader healthcare systems. Our findings indicate that stratification tools for older adults with multimorbidity are primarily used to identify at-risk patients, but their application is limited to clinical settings such as hospitals, outpatient clinics, and general practice. This limited use may be attributed to the considerable difficulty in developing, validating, and implementing stratification tools that are suitable for use across multiple sectors. These challenges arise from differences in the populations served by each sector, the resources available for stratification, and variations in clinical workflows and needs.[42] Furthermore, stratification is part of the evolving landscape of precision medicine ...d individualised risk profiling, which has yet to be fully adopted across the healthcare

sector. This slow adoption is partly due to unresolved ethical challenges surrounding healthcare data sharing.[43]

A recent systematic review also revealed that risk stratification tools designed to predict healthcare utilisation are widely implemented in primary care, but often lack external validation and have been associated with either no change or increased healthcare utilisation when used to identify at-risk patients.[42] This suggests potential issues with the routine use and implementation of such tools across healthcare sectors. In our review, the Comprehensive Geriatric Assessment (CGA) emerged as the most frequently used tool for identifying patients for integrated care. This may be due to the CGA already being routinely implemented across many healthcare sectors, where older adults with multimorbidity are likely to present for assessment.[44] In addition, the CGA is not solely a tool for patient identification; it also functions as a multicomponent integrated care approach,[45] which may make it more practical to implement compared to separating risk stratification and integrated care into two distinct processes

The development, validation, and implementation of stratification tools require significant time and resources, and their utility depends on clinicians perceiving them as necessary and feasible within their daily routines. For example, the implementation of risk stratification in primary care is influenced by a facility's technological capabilities, staffing levels, and resource availability. Risk stratification has been reported as time-consuming and difficult to integrate into existing workflows,[46] which may help explain the knowledge gap identified in this review. This may also account for why none of the identified tools were used across multiple sectors. Tools intended for cross-sector use would likely require ev advanced technological infrastructure, greater staffing capacity, enhanced communication, and a more integrated healthcare service framework to support their implementation.

Based on our findings, we recommend that the development of future risk stratification tools for older adults with multimorbidity in an integrated care context should include: (a) a development phase that identifies risk factors related to the need for integrated care in older adults with multimorbidity, in collaboration with stakeholders from all sectors, to identify commonly presenting risk factors; (b) the development of causal loop diagrams, systems maps, and the use of exploratory machine learning on existing data to uncover additional risk factors not identified by stakeholders; (c) internal and external validation of the tools on populations across sectors, with training of the risk stratification models on multiple data s (e.g., qualitative interviews, patient-reported outcome measures, objective measures) across various settings (e.g., primary care, clinics, municipalities); and (d) collaboration

on the implementation of the tools in practice across diverse healthcare sectors. Interventions that involve the development and use of stratification tools could benefit from established frameworks for complex interventions, such as the Medical Research Council (MRC) Framework, which encompasses all phases from development to implementation.[47]

While our study benefited from stakeholder involvement and a thorough, inclusive search strategy, it also had several limitations. These include the exclusion of specific search terms due to the varying definitions of integrated care and multimorbidity. Furthermore, our findings were limited by the inclusion of only peer-reviewed articles, which may have excluded relevant grey literature or unpublished studies.

Conclusion

We identified several knowledge gaps related to stratification tools for older adults with multimorbidity in an integrated care context. Our findings revealed that risk stratification is underdeveloped and suffers from heterogeneity in scoring methods, items, and measurement domains. We observed that stratification was primarily used to identify older adults with multimorbidity for referral to multidisciplinary teams or to assign a care manager. Notably, the most widely used tools were not originally designed with multimorbidity in mind, despite the fact that multimorbidity is highly heterogeneous even among older adults. Many of the tools identified, such as the Comprehensive Geriatric Assessment, are already implemented in clinical practice, which may explain their widespread use. Future development of risk stratification tools should be ca[...] collaboration across healthcare sectors. Implementation efforts must consider the technological capabilities, staffing levels, and resource availability within the intended setting. To ensure successful adoption in clinical practice, tools must be easy to use, straightforward, and not impose significant time or resource burdens.

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Ethical considerations

There are no human participants in this article and informed consent is not required.

Declaration of conflicting interests

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Data availability statement

All search matrices are included in the Supplemental Material. Data from Covidence can be retrieved upon request to corresponding author(s).*

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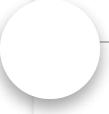
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