Received: 7 May 2021 | Revised: 9 August 2021 | Accepted: 16 August 2021

DOI: 10.1111/jocn.16035

REVIEW

Journal of Clinical Nursing WILEY

Frailty measurements in hospitalised orthopaedic populations age 65 and older: A scoping review

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Abstract

Aims and Objectives: To identify and compare frailty instruments used with hospitalised orthopaedic patients aged over 65.

Background: Frailty predicts clinical events in orthopaedic patients aged over 65. However, the strengths and limitations of different approaches to measuring frailty in this population are rarely discussed. As such, a comprehensive review to address the gap is needed.

Design: Scoping review using Arksey and O'Malley framework.

Methods: PubMed, CINAHL, PsycINFO, Scopus and EMBASE databases were searched to identify studies published from 2006 to 2020 regarding frailty instruments in older orthopaedic patients. The Preferred Reporting Items for Systematic Reviews and Meta-analyses were followed.

Results: The initial search resulted in 1,471 articles. After review against inclusion and exclusion criteria, a final set of 31 articles containing 15 unique frailty instruments were evaluated. Most of the articles were from Western countries. Fried's phenotype and Frailty Index were commonly used. The frailty index was mostly modified to measure frailty. In hip fracture, physical function items were frequently modified in the measurement of frailty. Trained physicians and nurses administered most frailty instruments. Frailty screening was commonly conducted at hospital admission and used to prognosticate both postoperative complications and hospital outcomes. Most instruments could be completed within 10 min. Reported psychometrics had acceptable reliability and validity.

Conclusion: Many reliable frailty measures have been used in the inpatient orthopaedic settings; however, evidence is still lacking for a gold standard frailty instrument. More research is needed to identify the best-performing measure. Frailty evaluation in patients with physical limitations is challenging with existing instruments. Clinical context, resources required and instrument quality are essential factors in selecting a frailty instrument.

Relevance to clinical practice: Musculoskeletal symptoms in older patients may bias frailty assessment. Proactive frailty screening with valid and practical instruments is vital to strengthen preoperative risk stratification and improve post-surgical outcomes.

KEYWORDS
aged, frailty, hospital, measurement, older adults, orthopaedic, outcomes, patients, scoping review, surgical

1 | INTRODUCTION

As life expectancy has increased, promotion of healthy ageing, maintenance of functional ability and support of well-being in older adults has become a global priority (World Health Organization, 2017). In older adults, musculoskeletal (MSK) conditions are expected, have a negative impact on functional ability and lead to an increased burden of disease (Briggs et al., 2016; Briggs & Dreinhofer, 2017). To slow down or reverse the functional decline, surgical treatment may be required. Orthopaedic surgeries for conditions like hip, knee and spine degeneration have increased, with a parallel rise in postoperative complications and mortality seen in older populations (Gleason et al., 2017; McIsaac et al., 2018; Rothrock et al., 2018; Segal et al., 2018; Wilson et al., 2018). Frailty is a syndrome that has emerged and been identified as an important concept that captures older adults' vulnerability to adverse health events (Fried et al., 2001, 2004). Although the prevalence of frailty is low in MSK conditions [approximately 4.9–10.7%; (Choi et al., 2015; Nguyen et al., 2015)], it is associated with degenerative MSK conditions such as rheumatoid arthritis, osteoporosis and osteoarthritis (Milte & Crotty, 2014; Zlobina et al., 2015). Frailty is also linked to an increase in adverse surgical outcomes and postoperative complications (Ondeck et al., 2018; Theou et al., 2018). Frail older adults with MSK conditions are at higher risk of mortality, fall-related injury, disability and hospital readmission (Bellamy et al., 2017; Charest-Morin et al., 2018; Ondeck et al., 2018; Shin et al., 2016; Walters et al., 2016). There is no proven pharmacological treatment to reverse frailty. Prevention and early screening of frailty can improve clinical care if used for risk stratification (Dent et al., 2016; Theou et al., 2018), treatment decision-making and surgical planning. Hence, identifying and using efficient frailty screening instruments could delay dependency, promote health and support the well-being of older orthopaedic populations.

Despite the opportunities of screening for frailty in orthopaedic populations, challenges remain. The first challenge is to identify which instruments provide accurate frailty identification in orthopaedic patients. Evidence underlined that the musculoskeletal ageing phenotype, comprising osteoporosis, osteoarthritis (OA) and sarcopenia may affect the accuracy of a frailty evaluation (Dasgupta et al., 2009; Kistler et al., 2015; Krishnan et al., 2014; Kua et al., 2016).

What does this paper contribute to the broader global clinical community?

- Frailty is a common syndrome associated with poorer health outcomes in older orthopaedic patients. The clinical manifestations of musculoskeletal (MSK) conditions in this population may bias frailty classification; thus, tailored frailty assessment to be specific frailty instruments might be efficient in improving quality of care.
- The scoping review identified 15 valid frailty instruments used in orthopaedic settings to guide the clinicians to stratify risk before operation. The Reported Edmonton Frail Scale, FRAIL Scale, PRISMA-7 and Groningen Frailty Index may be practical with time efficient and less requirements for administration; however, further validated instruments for specific orthopaedic conditions or settings are crucial.
- Current evidence is insufficient to prioritise one frailty instrument over another for screening older orthopaedic patients; therefore, clinical context, resources and pragmatic considerations should guide the decision for frailty instrument selection. Integrating additional resources—such as family member input or biomarkers—might be beneficial for monitoring frailty trajectories.

The predominant clinical characteristics of orthopaedic patients, particularly physical limitations, weakness or immobility due to pain and neuromuscular impairment may cause a misinterpretation of someone being frail (Beaudart et al., 2015; Chen et al., 2014; Collino et al., 2013). As such, orthopaedic patients who are frail may present either as highly sensitive or insensitive to frailty measures. A recent study underlined that selecting a frailty instrument that fits with a specific orthopaedic population may be the best for clinical risk stratification (Mahmooth et al., 2020). Awareness of frailty emerged for more than two decades; however, no previous evidence regarding frailty instruments has been closely investigated in the orthopaedic population. The second challenge in assessing frailty is how to apply assessment tools in diverse inpatient settings. Although various measures have been developed, frailty instruments are unavailable in many geographical areas and languages (Buta et al., 2016). Overcoming language barriers and cultural issues to assess frailty is vital for better care.

Commonly used frailty measures may not be suitable for all hospital settings because of resource limitations, clinical context, instrument quality and cultural sensitivity considerations (Buta et al., 2016; Theou et al., 2018). Clinical contexts might be specific to equipment availability, time to complete the assessment, the measure's quality and cultural sensitivity. Recently, a scoping review (Church et al., 2020) was published focusing on the Clinical Frailty Scale, but reviews assessing other frailty instruments have not been assessed. To gain better knowledge about frailty instruments used in the orthopaedic population, conducting a new scoping review has advantages over other forms of review in providing a broad perspective (Grant & Booth, 2009) and clarifying a basis for currently implementing frailty instruments in this population. Research into frailty assessment has a long history; therefore, analysing different frailty instruments in the inpatient orthopaedic population is critical to inform care by applying clinical judgment-based frailty instruments correctly. This review covers the gaps mentioned above and provides information about frailty instruments used by clinical specialists and healthcare providers caring for patients with orthopaedic conditions.

2 | METHODS

2.1 | Aim

To identify and compare frailty instruments used with hospitalised patients aged over 65.

2.2 | Design

The Arksey and O'Malley framework (2005) was used as a guide for this review. The framework has five steps: 1) identifying the research question; 2) identifying relevant studies; 3) study selection; 4) charting the data; and 5) assembling, summarising and reporting the results.

2.3 | Methods and search strategy

Stage 1: identifying the research question

The first stage included a preliminary exploration of the literature to identify knowledge gaps on frailty in hospitalised orthopaedic patients. Research questions for this review were as follows: 1) What frailty instruments are currently in use in inpatient orthopaedic settings?; 2) Which instruments are reliable and practical to measure frailty in an inpatient orthopaedic setting?

Stage 2: identifying relevant studies/search strategy

Two co-authors (IR & OZ) performed the literature search in consultation with a health science librarian. The search was conducted in the main health databases—PubMed, CINAHL, PsycINFO, Scopus and EMBASE. The combination of Medical Subject Headings (MeSH) and keywords were modified for each database to optimise search strategies. The search included publications from 1 July 2006 to 31 December 2020. Keywords used were 'frailty', 'orthopaedic', 'instrument' or 'scale' or 'indicator', and 'older adults'. The search strategies are presented in the supplement (Appendix S2). Last, the co-authors (IR, OZ and SA) independently verified search terms and discussed initial results to confirm the strategies performed.

Stage 3: study selection

Peer-reviewed original research articles and hand-searched articles retrieved from the databases were considered eligible for review. The articles that have not been formally published or archived in a peer-review format, such as conference proceedings, preprints, policy or hospital reports, and the grey literature was not included.

Eligibility criteria

The inclusion criteria were as follows: 1) article included frailty instrument(s); 2) the instrument was completed by hospitalised older adults or also by healthcare providers; 3)the average age of study participants was 65 years or older; 4) setting was hospital orthopaedic settings (units, wards or surgical department including orthopaedics); 5) article was written in English; and 6) published between July 2006 and December 2020. The exclusion criteria were articles: 1) unrelated to frailty; 2) focused on frailty in community settings; and 3) mentioned frail patients without measuring frailty.

Selection of studies for inclusion

Following the initial search, two co-authors (IR and SA) independently reviewed the titles and abstracts to determine eligibility. Next, they independently reviewed full-text articles and identified potential articles for inclusion. A third person arbitrated any disagreement among the initial reviewers. The third person (OZ) reviewed the articles in which there was disagreement about inclusion between initial reviewers, discussed and decided to include or exclude. The workflow was summarised using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guideline for scoping reviews (Figure 1) (Page et al., 2021; Tricco et al., 2018). Checklist of Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) are presented in File S1.

Stage 4: charting the data

The combination of Microsoft Excel 2016, EndNote X7 and Rayyan application was used to remove duplicates and build a summary

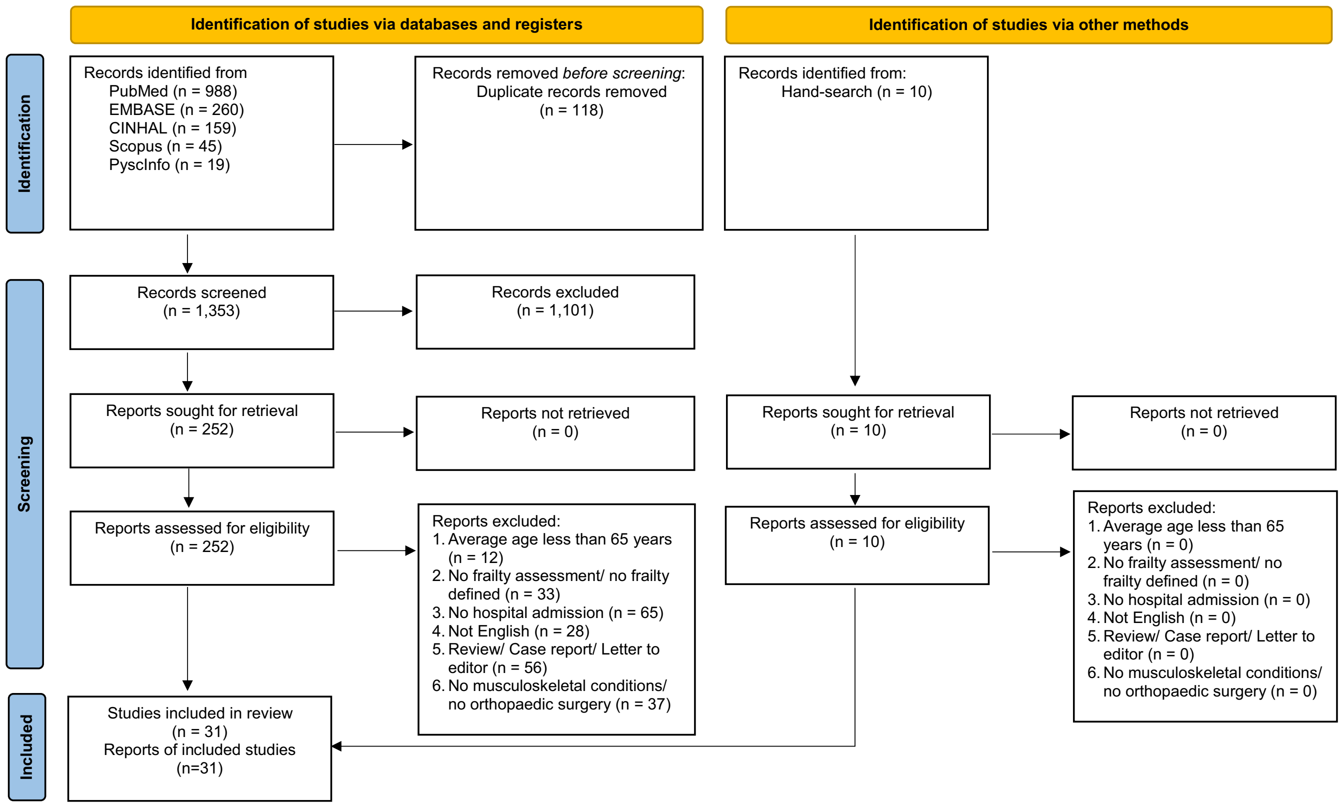

FIGURE 1 PRISMA 2020 flow diagram [Colour figure can be viewed at wileyonlinelibrary.com]

table focusing on: the country the study was conducted in, study design, name of frailty instrument, number and type of items, administration instructions and time to complete the instrument, scoring, population, health outcomes, instrument requirement and quality of the instrument. A subset of five studies was selected to pilot data extraction and valid agreement evaluation before beginning the complete review processes.

Stage 5: assembling, summarising and reporting the results

The identified studies were summarised, and relevant data were abstracted (Table 1, Appendix S2). Following Arksey and O'Malley (2005), no quality appraisal of the included studies was conducted. The reliability, responsiveness and validity of each frailty instrument were evaluated based on the standard measurement properties of health questionnaires (Terwee et al., 2007).

3 | RESULTS

3.1 | Characteristics of publications

The search initially identified a total of 1,471 articles (Figure 1). After duplicate articles were removed and abstracts screened, 262 articles were included for final review, with 95 percent agreement between three reviewers. After a full-text review, 31 articles were retained and evaluated for this review. Studies in the final sample included hospitalised older adults in orthopaedic settings (Tables 1 and 2). Data for the articles were collected in the United States (*n* = 9); United Kingdom (*n* = 4); Canada (*n* = 3); Korea (*n* = 2); Singapore (*n* = 2); Taiwan (*n* = 1); and Thailand (*n* = 1). Sixteen percent of the studies used retrospective designs (*n* = 5). Of all included studies, there were 681,684 orthopaedic patients; the average age of participants was 81 (range 65–92) years old; nearly 60% of these participants were female. Study participants had multiple comorbidities and underwent orthopaedic surgical procedures, mostly were related to the knee (51.59%), hip (39.53%) and non-specific orthopaedic conditions (5.91%) (Figure 2). We identified 15 unique frailty instruments. Translation and cross-cultural validation were mentioned for 8 instruments (53.33%; Table 2).

3.2 | Frailty instruments used in an orthopaedic setting

Different frailty concepts led to differences in operational definition, structural domains, scales and scorings across the studies. Fifteen frailty instruments were identified (Table 1): the Edmonton Frailty Scale (EFS); modified Frailty Index (mFI)/Simplified Frailty Index; Fried's Phenotype criteria (FP criteria); Frailty Index (FI); Modified Fried Index; Modified Fried's Criteria (MFC); Reported Edmonton Frailty Scale (REFS); Hip-Multidimensional Frailty Score (Hip-MFS); Maastricht Frailty Screening

TABLE 1 Summary of characteristics of frailty instruments commonly used in orthopaedic patients

Frailty Instrument	Domains	Population/References	Outcome of interest
EFS	**Nine domains (9 items):** Cognitive impairment, dependence on daily activity living, recent burden illness, self-perceived health, depression, weight loss, medication issues, incontinence, inadequate social support and mobility difficulty.	A single non-cardiac surgery (mean age 77)/(Dasgupta et al., 2009)	• Postoperative complications, the length of hospital stay (LOS) and ability to be discharged home in older adults undergoing elective non-cardiac surgery
EFS		Vertebral fracture (mean age 80)/(Walters et al., 2016)	• Functional ability, cognitive function, the prevalence of frailty in fragility fracture of hip and vertebral fracture.
mFI	**Eleven domains (11 items)** from the Canadian Study of Health and Aging Frailty Index (CSHA-FI) matched to items from the American College of Surgeons National Surgical Improvement Program (NSQIP): change in everyday activity, problems with getting dressed, history of diabetes mellitus, lung problems, respiratory problems, congestive heart failure, myocardial infarction, cardiac problem, cerebrovascular problem, history of stroke and decrease peripheral pulses.	Primary TKA & THA (mean age 66)/(Shin, 2016)	• Clevein-Dindo classification gr. IV • Hospital-acquired conditions • Any complications • Mortality
mFI		THA (mean age 82)/(Ondeck et al., 2018)	• Occurrence of adverse events • Death • Severe and minor adverse events • Extend hospital stay.
mFI		Orthopaedic surgery (mean age 79.5)/(Vu et al., 2017)	• 30 days Mortality • Postoperative complication • 30 days reoperation • Readmission • Adverse discharge • LOS
mFI		THA (mean age 71.2)/(Bellamy, 2017)	• Readmission • Any complications • Reoperation • Adverse discharge • Mortality • Specific complications after THA regardless of age
mFI		Primary TKA (mean age 70.75)/(Runner, 2017)	• Postoperative complications • Reoperation • Readmission
mFI		Non-complex lumbar spine surgery (median age 72)/(Charest-Morin et al., 2018)	• Occurrence of any perioperative adverse events • Postoperative complication • LOS • Postoperative discharge to a facility • In-hospital mortality.
mFI		Intertrochanteric femur fractures (mean age 73)/(Boissonneault et al., 2019).	• The 30-day morbidity and mortality post-surgery.

(Continues)

TABLE 1 (Continued)

Frailty Instrument	Domains	Population/References	Outcome of interest
FP criteria	**Five domains (5 items)** and adapted some domains by using self-report due to patient conditions: Shrinking (self-reported), exhaustion (self-reported), slowness (self-reported), weakness (grip strength) and physical activity (Minnesota leisure time questionnaire)	Hip fracture (mean age 86)/(Kistler et al., 2015)	• Postoperative complications during hospital admission • LOS • Complications such as pneumonia, cardiac complications, surgical site infection, deep vein thrombosis and/or pulmonary embolism, bleeding, renal insufficiency or failure and delirium
FP criteria	**Five domains (5 items)** as CHS and Women's Health and Aging Study (WHAS): Slow gait (3m-walk), weakness (grip strength), low activity (energy expenditure), involuntary weight loss and exhaustion	Orthopaedic surgery (mean age 77)/(Cooper et al., 2016)	• Relationship between FP criteria and FI with baseline demographic and functional measure • Postoperative complications • LOS • Discharge to Post-Acute Institutional Care (PAC) • Readmission within 300 days
FP criteria		Lumbar spine stenosis (mean age 71)/(Kim et al., 2018)	• Back-specific function outcome • Quality of life
FP criteria		General elective non-cardiac surgical patients (mean age 74)/(Birkelbach O. et al., 2019).	• Postoperative complications
FI	**Multiple domains (51 deficit domains)** based on deficits identified at the time of assessment	Hip fracture (mean age 81)/(Krishnan et al., 2014)	• LOS • Overall hospital outcomes at 30 days after admission.
FI	**Multiples domains (42 deficits domains)**	Orthopaedic surgery (mean age 77)/(Cooper, 2016)	• Postoperative medical and surgical complications • LOS (≥ 5days) • Discharge to PAC • Readmission within 300 days.
FI	**Multiple domains (70 deficits domains)**	Patients with elective surgeries for spinal disorders (mean age 65)/(Yagi et al., 2018)	• Postoperative health-related quality of life and complication rates.
FI	**Multiple domains (29 deficits domains)**	Fragility fracture in DM type 2 patients (mean age 65)/(Li et al., 2019)	• Incidence of fragility fractures, hip fracture and clinical spine fracture required surgical treatment.
FI	**Multiple domains (32 deficits domains)**	Patients who were undergoing unilateral primary or revision THA (median age 68)/(Johnson et al., 2019b)	• Perioperative complications during hospitalisation • Complications within 90 days and within 1 year.
FI	**Multiple domains (32 deficits domains)**	Patients undergoing unilateral primary or revision TKA (median age 69)/(Johnson et al., 2019a).	• Postoperative complications and both immediate and 1-year outcomes after TKA.
MFC	**Modified five domains from FP criteria (5items)**: Exhaustion, weight loss, weakness, modified slowness and physical activity level	Hip fracture (mean age 79.1)/(Kua, 2016)	• Postoperative complications during hospital admission: delirium, pneumonia, constipation, cardiac problems, pulmonary embolism, deep vein thrombosis, stroke, gastrointestinal bleeding, new pressure sore, urinary tract infection and retention urine. • The 6 months functional parameter of the hip and mortality rate.

(Continues)

TABLE 1 (Continued)

Frailty Instrument	Domains	Population/References	Outcome of interest
Modified Fried Index	**Modified five domains from CHS (5 items):** Weight loss (>101 lbs unintentionally in the prior year), grip strength (lowest 20% by gender and body mass index), exhaustion (self-report), slowness (asking about 15 feet walking ability speed by gender and height) and low activity (kilocalories per week male<383, female<270).	Surgical patients included orthopaedic (mean age 73)/(McIsaac et al., 2018)	• All-cause mortality • New disability 90 days after surgery • LOS • Total cost in hospital • Discharge disposition • Any complications and adverse events
REFS	**Nine domains (13 items):** General health status, nutrition, self-reported performance, functional independence, cognition, social support, medication use, mood and continence	Hip fracture (mean age 79.1)/(Kua, 2016)	• Postoperative complications during hospital admission: delirium, pneumonia, constipation, cardiac problems, pulmonary embolism, deep vein thrombosis, stroke, gastrointestinal bleeding, new pressure sore, urinary tract infection and urine retention. • The 6 months functional parameter of the hip and mortality rate
REFS-Thai		Older adults who scheduled for elective orthopaedic surgery (mean age 72)/(Roopsawang et al., 2020)	• Postoperative complication and adverse events during hospital admission, postoperative delirium, discharge disposition and length of stays.
Hip-MFS	**Eight domains (8items):** Serum albumin level, mid-arm circumference, Charlson comorbidity index, walking dependency, cognitive function, risk of fallings, nutrition status and sex	Hip fracture (mean age 80.4)/(Choi, 2017)	• At 6 months, all-cause mortality • Postoperative complications • LOS • Prolonged total hospital stay institutionalisation • 1-year all cause of mortality
MFST-HP	**Three domains (15 items):** physical (9 items), psychological (4 items) and social (2 items).	Hospitalised older adults including orthopaedic (mean age 76.7)/(Warnier, 2016)	• Intra and inter-rater reliability • Feasibility • Construct validity
5 items mFI	**Five Domains (5 items)**: History of Diabetes Mellitus, Congestive Heart Failure (new diagnosis or exacerbation of chronic congestive heart failure within 30 days of surgery), hypertension requiring medication, history of chronic pulmonary disease or pneumonia, and non-independent functional status (wholly or partially dependent in activities of daily living within the last 30 days prior to surgery).	Patients undergoing distal radius fracture procedure (mean age 65)/(Wilson et al., 2018)	• Postoperative complication after receiving orthopaedic surgery in Distal Radius fracture • Readmission • Reoperation • LOS
5 items mFI		Patients undergoing Kyphoplasty vertebral augmentation (mean age 73.98)/(Segal et al., 2018)	• 30 days postoperative complication • Reoperation • Readmission • LOS
5 items mFI		Patients undergoing total joint arthroplasty (mean age 66) (Traven, Reeves, Sekar, Slone, & Walton, 2019)	• Postoperative compilations • Surgical site infection • Readmission • 30 days mortality
5 items mFI		Patients undergoing total shoulder arthroplasty (mean age 70.4) (Holzgrefe et al., 2019)	• 30 days Postoperative compilations • Reoperation • Readmission • Adverse hospital discharge • Mortality

(Continues)

TABLE 1 (Continued)

Frailty Instrument	Domains	Population/References	Outcome of interest
CFS	**Four domains (N/A items):** Mobility, energy, physical activity and function	Surgical patients included orthopaedic (mean age 73)/(McIsaac et al., 2018)	• All-cause mortality • New disability 90 days after surgery • LOS • Total cost in hospital • Discharge disposition • Any complications and adverse events.
CSHA-CFS		Hip fracture (mean age 78) (Chen et al., 2019).	• Mortality, emergency department visit and readmission at 1, 3,6 months after surgery.
FRAIL scale	**Five Domains (5 items):** Fatigue, resistance, aerobic capacity, illness and weight loss.	Spine surgery (median age 71)/(Rothrock et al., 2018)	• Postoperative physical functional and cognition recovery in 3 months.
FRAIL scale		Orthopaedic trauma surgery(mean age 82.3)/(Gleason et al., 2017)	• Postoperative complication • Unplanned ICU admission • LOS • Discharge disposition • 30 days readmission • 30 days mortality.
PRISMA–7	**Seven Domains (7 items):** Age >85 years, male gender, health problems that limit activities, needs for support by others, health problems that require staying home, or someone taking care of, using a walker or wheelchair.	Vertebral fracture (mean age 80)/(Walters et al., 2016)	• Functional ability • Cognitive function • Prevalence of frailty in fragility fracture of hip and vertebral fracture.
GFI	**Four Domains (15 items):** Physical, cognition, social and psychological.	Vertebral fracture (mean age 80)/(Walters et al., 2016)	• Functional ability • Cognitive function • Prevalence of frailty in fragility fracture of hip and vertebral fracture.
GFI		Patients who underwent hip fracture surgery (mean age 83)/(Winters, Hartog, Roijen, Brohet, & Kamper, 2018).	• Postoperative delirium • Survival and mortality at 30 days and 3 years after surgery

Abbreviations: 5 items mFI, 5 items modified Frailty Index; CFS, Clinical Frailty Scale; CSHA-CFS, Chinese-Canadian Study of Health and Aging Clinical Frailty Scale; EFS, Edmonton Frail Scale; FI, Frailty Index; FP criteria: Fried's Frailty Phenotype criteria; FRAIL scale, Fatigue, Resistance Ambulation, Illness and Loss of Weight scale; GFI, Groningen Frailty Indicator, THA, Total hip arthroplasty; Hip-MFS, Hip-Multidimensional Frailty Score; MFC, Modified Fried's Criteria; mFI, Modified/Simplified Frailty Index; MFST-HP, Maastrich Frailty Screening Tool for Hospitalized Patients; REFS, Reported Edmonton Frail Scale; TKA, Total knee arthroplasty.

Tool for Hospitalized Patients (MFST-HP); 5-item mFI; Clinical Frailty Scale (CFS); Chinese-Canadian Study of Health and Aging Clinical Frailty Scale (CSHA-CFS); FRAIL Scale (Fatigue, Resistance, Ambulation, Illnesses and Loss of Weight); PRISMA-7; and Groningen Frailty Index (GFI). Across all instruments, the number of frailty domains varied from two to more than ten domains. The number of items ranged from 5 (e.g. FP criteria) to 51 items (e.g. Frailty Index). Self-report combined with other assessment methods (66.67%, n = 10) were used. One tool—the CFS stated using clinical descriptors, pictographs of activity and functional assessment for frailty screening. Six frailty instruments (40%) were modified from the originally published instruments (Table 2).

Deficit accumulation (n = 6) and phenotype-informed (n = 4) were the main approaches to determine frailty; notably, the deficit accumulation of frailty was widely modified for measuring frailty (n = 11). Physical function, fatigue, weight loss, cognitive function, limitation of activities and comorbidity were common criteria across instruments (n = 14). Two instruments, the FP criteria (Kistler et al., 2015) and MFC (Kua et al., 2016), were used to measure frailty in hip fracture patients and modified physical function/walking performance measures in order to allow for self-report (Table 1). Most instruments used a binary cut-off point (frail/non-frail), but the FI had more than one cut-off to quantify frailty severity. Frailty was commonly measured pre-operatively (100%). Frailty assessments were used to predict short and long-term outcomes such as postoperative complications (19 studies), length of stay (LOS [15 studies]), mortality rate (13 studies), discharge disposition (12 studies), physical or cognitive function (10 studies), readmission (9 studies), any adverse events (7 studies) and reoperation (5 studies).

3.3 | Data sources, equipment and training

Assessing frailty required different resources (Table 2). Most frailty instruments required training for use (n = 10, 66.66%), while many used other standard assessment information (n = 5, 33.33%) or additional equipment (n = 4, 26.66%). The mFI, FI, MFST-HP and 5 items mFI required information from medical records. The Hip-MFS relied on many sources, including standard assessment information, physical performance, laboratory testing, mid-arm circumference and specific training to evaluate frailty. The PF criteria required training, physical performance testing and specific equipment (a hand-grip strength dynamometer). The Modified Fried Index and MFC also needed specific training and a dynamometer. In contrast, only four frailty instruments (REFS, Frail Scale, PRISMA-7 and GFI) obviated the need for specific equipment and training to measure clinical frailty.

3.4 | Measurement occasion and time

All frailty instruments were utilised for preoperative assessment on hospital admission. Of these, in two instruments, the authors selected a time point to measure frailty: the MFST-HP was used to assess frailty at 48 hrs post-hospital admission, while the FRAIL Scale was used to evaluate frail status on the first day of hospital admission.

The time spent to complete the frailty measures was reported in less than half the studies (n = 6; 47%), with time to complete ranging between 1 and 10 mins (n = 6). The MFC, MFST-HP and Modified Fried Index were completed within <6 mins. Employing the REFS, however, the patients needed approximately 5 mins to complete it. The CFS and CSHA-CFS were reportedly completed within 3 mins (Table 2).

3.5 | Human resources

Evaluating frailty, the MFST-HP was used by registered nurses (RNs) without additional training (Warnier et al., 2016). The other frailty instruments used trained research staff, such as physicians, to administer the frailty instruments (n = 14). All frailty instruments assessed the frailty status of the patients, yet none of these studies mentioned other people such as proxy, caregivers or family members who might be involved in the evaluation. Staff requested assistance with using frailty instruments that included data from other sources and/or trained personnel.

3.6 | Quality of instrument properties

One article referred to content validity testing of the REFS-Thai (Roopsawang et al., 2020a, 2020b). Two articles that included the REFS-Thai (Roopsawang et al., 2020a, 2020b) and MFST-HP mentioned construct validity testing (Warnier et al., 2016). Eighty-three per cent of the articles (n = 25) reported criterion validity; the American Society of Anesthesiologists (ASA), Charlson Comorbidity Index (CCI) and other standard instruments were frequently selected to confirm validity testing (Bellamy et al., 2017; Choi et al., 2017; Cooper et al., 2016; Dasgupta et al., 2009; Holzgrefe et al., 2019; Kua et al., 2016; Roopsawang et al., 2020a; Runner et al., 2017; Shin et al., 2016; Vu et al., 2017). Three instruments (EFS, PRISMA-7 and GFI) tested criterion validity with other frailty instruments (Walters et al., 2016). The FP criteria, FI, MFST-HP and CSHA-CFS were verified for reliability. The MFST-HP demonstrated excellent reliability, both intra-rater and inter-rater (ICC (intra-rater) =0.93, ICC (inter-rater) =0.95) (Warnier et al., 2016) (Appendix S2). Poor reliability (weighted Kappa <0.6) was reported in FP criteria and FI (K = 0.53 (95% CI 0.44–0.61), 0.42 (95% CI 0.36–0.49), respectively) (Cooper et al., 2016). The MFC mentioned reliability from original studies, but not in the orthopaedic population (Kua et al., 2016). Forty per cent of frailty instruments (n = 6) were evaluated for responsiveness: EFS (Dasgupta et al., 2009), mFI (Boissonneault et al., 2019; Ondeck et al., 2018), Hip-MFS (Choi et al., 2017), Modified Fried's Index and CFS (McIsaac et al., 2018) demonstrated intermediate quality; however, the REFS-Thai (Roopsawang et al., 2020a) indicated excellent quality. The FI (Krishnan et al., 2014) and REFS-Thai (Roopsawang et al., 2020a) showed good quality in predicting most of the adverse clinical outcomes (Figure 3 and Appendix S2). The findings of this scoping review demonstrated that most of the frailty instruments were valid, but more investigation is needed regarding reproducibility [agreement or reliability (36.6%)], responsiveness (34.14%) and cross-cultural validation (23.17%) (Figure 3, Table 2 and Appendix S2). These results suggest that the FI, REFS-Thai and MFST-HP demonstrated an acceptable to good quality and predictability; while FRAIL Scale, REFS-Thai, PRISMA-7 and GFI may be practical tools for evaluating frailty in orthopaedic patients as they require no equipment nor training for administration (Figure 3, Table 2 and Appendix S2). Notably, current evidence is insufficient to prioritise one frailty instrument over another for screening older orthopaedic patients.

4 | DISCUSSION

This scoping review identified and evaluated 15 unique, reliable frailty instruments used with hospitalised older adults in orthopaedic settings. The Frailty Index and Fried phenotype were the most commonly used. Modification of frailty instrument, particularly physical function assessment, was frequently identified in hip fracture patients. This review adds to the literature by critically examining frailty instruments when used in older inpatient orthopaedic populations.

Across all studies, regardless of instrument, where the outcome was measured, frailty resulted in increased postoperative complications, adverse events, reoperation, readmission, mortality rate and prolonged LOS, and differences in discharge disposition. In orthopaedic settings, however, more evidence is needed to identify the best-performing frailty instrument.

Based on our review, there are three potential concerns in selecting an instrument for identifying frailty in orthopaedic

TABLE 2 Comparison and evaluation of frailty instruments commonly used in orthopaedic settings

Comparison	Measurement														
	EFS	mFI	PF Criteria	FI	Modified Fried Index	MFC	REFS	Hip-MFS	MFST-HP	5 items mFI	CFS	CSHA-CFS	FRAIL-Scale	PRISMA–7	GFI
Country of study	US/UK	CA/US	US/KR	US/UK	CA	SG	SG TH	KR	US	US	US	TW	US	US	UK
Retrospective study design		√						√			√		√	√	
Administration:															
Observation															
Self-reported only												√	√	√	√
Self-reported +performance			√		√	√	√								
Self-reported +other standard assessments	√	√		√				√	√	√	√				
Frailty Domains	10	11	5	10^{+}	5	5	9	8	3	5	4	2	5	7	7
Number of items	10	11	5	51, 42	5	5	13	8	15	5	N/A	N/A	5	7	15
Cut-off point of frailty	≥ 7	≥ 0.25	≥ 3	Varies	≥ 3	≥ 3	≥ 8	≥ 8	High score, more frail	≥ 2	≥ 4	≥ 5	≥ 3	≥ 3	≥ 4
Modified from the original measurement		√			√	√	√			√	√				
Requirement of measurement:															
Other assessment information	X	√	X	X	X	X	√	√	√	√	X	X	X	X	X
Specific equipment	X	X	√	X	√	√	X	√	X	X	X	X	X	X	X
Specific training	√	√	√	√	√	√	X	√	X	√	√	√	X	X	X
Time preference for measuring frailty															
Preoperative	√	√	√	√	√	√	√	√	48 h. post-admission	√	√	√	1st day of admission	√	√
Human resources involved															
Researcher/Training	√	√	√	√	√	√	√	√		√	√	√	√	√	√
Nurses									√						
Content validity	√	X	√	X	X	X	√	X	X	X	X	X	X	X	X
Internal consistency	X	X	X	√	X	X	√	X	X	X	X	X	X	X	√

(Continues)

TABLE 2 (Continued)

	Measurement														
Comparison	EFS	mFI	PF Criteria	FI	Modified Fried Index	MFC	REFS	Hip-MFS	MFST-HP	5 items mFI	CFS	CSHA-CFS	FRAIL-Scale	PRISMA-7	GFI
Criterion validity	√	√	√	√	√	√	√	√	X	√	X	√	√	√	√
Construct validity	X	X	X	X	X	X	√	X	√	X	X	X	X	X	X
Reliability	X	X	X	√	X	X	√	X	√	X	X	X	X	X	X
Responsiveness	X	√	X	√	√	X	√	√	X	X	√	X	X	X	X
Time to complete (minutes)	N/A	N/A	N/A	<10	<6	3–5	≤5	N/A	<3	N/A	<1	<3	N/A	N/A	N/A
Cross-culture validation study	√	N/A	N/A	√	N/A	N/A	√	N/A	N/A	N/A	√	√	√	√	√

Abbreviations: CA, Canada; CFS, Clinical Frailty Scale; CSHA-CFS, Chinese-Canadian Study of Health and Aging Clinical Frailty Scale; EFS, Edmonton Frail Scale; Fatigue, Resistance Ambulation, Illness and Loss of Weight scale; FI, Frailty Index; FP criteria: Fried's Phenotype Criteria; GFI, Groningen Frailty; Hip-MFS, Hip-Multidimensional Frailty Score; KR, South Korea; MFC, Modified Fried's Criteria; mFI, Modified/Simplified Frailty Index; MFST-HP, Maastrich Frailty Screening Tool for Hospitalized Patients; REFS, Reported Edmonton Frail Scale; SG, Singapore; TH, Thailand; TW, Taiwan; UK, United Kingdom; US, The United States of America; √, report; X, no report; N/A, No information.

patients. First, understanding the clinical context, such as the clinical orthopaedic characteristics, is essential in measuring frailty. Although our findings revealed few commonalities across frailty instruments, adjustment of these instruments may be necessary in orthopaedic clinical populations. The review revealed that some authors modified existing frailty instruments, including tailoring scores, changing cut-off points and adapting components from the original version. The FP criteria were altered. Its name was changed to measure frailty: MFC and Modified Fried Index. These findings are similar to a meta-analysis analysing current frailty instruments that indicated that there were 262 different versions of the FP criteria used in clinical settings (Theou et al., 2015). Clinical characteristics of orthopaedic patients such as poor physical function, muscle loss/weakness and posture imbalances may impede interpretation of a frailty assessment. A few frailty instruments have been created for specific MSK conditions like the Hip-MFS for hip fractures (Choi et al., 2017). The FP criteria (Kistler et al., 2015) and MFC (Kua et al., 2016) modified physical function components with the aim to precisely measure frailty in older adults with physical limitations. Our findings emphasise that identifying frailty using existing instruments in an orthopaedic population could be complicated due to the overlap between physical limitations and frailty, which impacts the interpretation of these measures (Dasgupta et al., 2009; Fried et al., 2004; Kistler et al., 2015; Krishnan et al., 2014; Kua et al., 2016). Tailored frailty assessment that suits specific orthopaedic populations may provide more in-depth clinical information (Mahmooth et al., 2020).

Second, it is crucial to identify the means needed to use a frailty instrument, such as equipment requirements and human resources. It is also essential to factor in the amount of time to complete the measure. Equipment costs for measuring frailty should be considered when selecting an instrument for use in limited-resource hospitals and clinics. The FP criteria, Modified Fried Index and MFC required objective measurement via a dynamometer to evaluate one component of frailty. The Hip-MFS used surrogate markers and specific laboratory values in evaluating frailty. Using only self-report for assessment of frailty has advantages; however, it may increase biases affecting frailty classification. Using a more sophisticated instrument that requires additional human resources requirements and equipment makes frailty evaluation less practical—in hospitals with staffing limitations, using instruments that do not require additional training, such as the REFS, FRAIL Scale, PRISMA-7 and GFI, may be most appealing. None of the studies mentioned other people—proxy, caregivers or family members who might be involved in frailty evaluation in this review. Integrating family members and caregivers to evaluate frailty may provide additional contextual and clinical information.

Our findings revealed a range of completion time for frailty screening (1–10 mins). Increasing the time of frailty assessment may depend on factors including the number of items, clinical experience, the specific MSK limitations and the complexity of the assessment. The majority of frailty instruments required the clinical experience of the users; thus, novice clinicians spent more time than experts in administering an instrument. Notably, functional limitation due

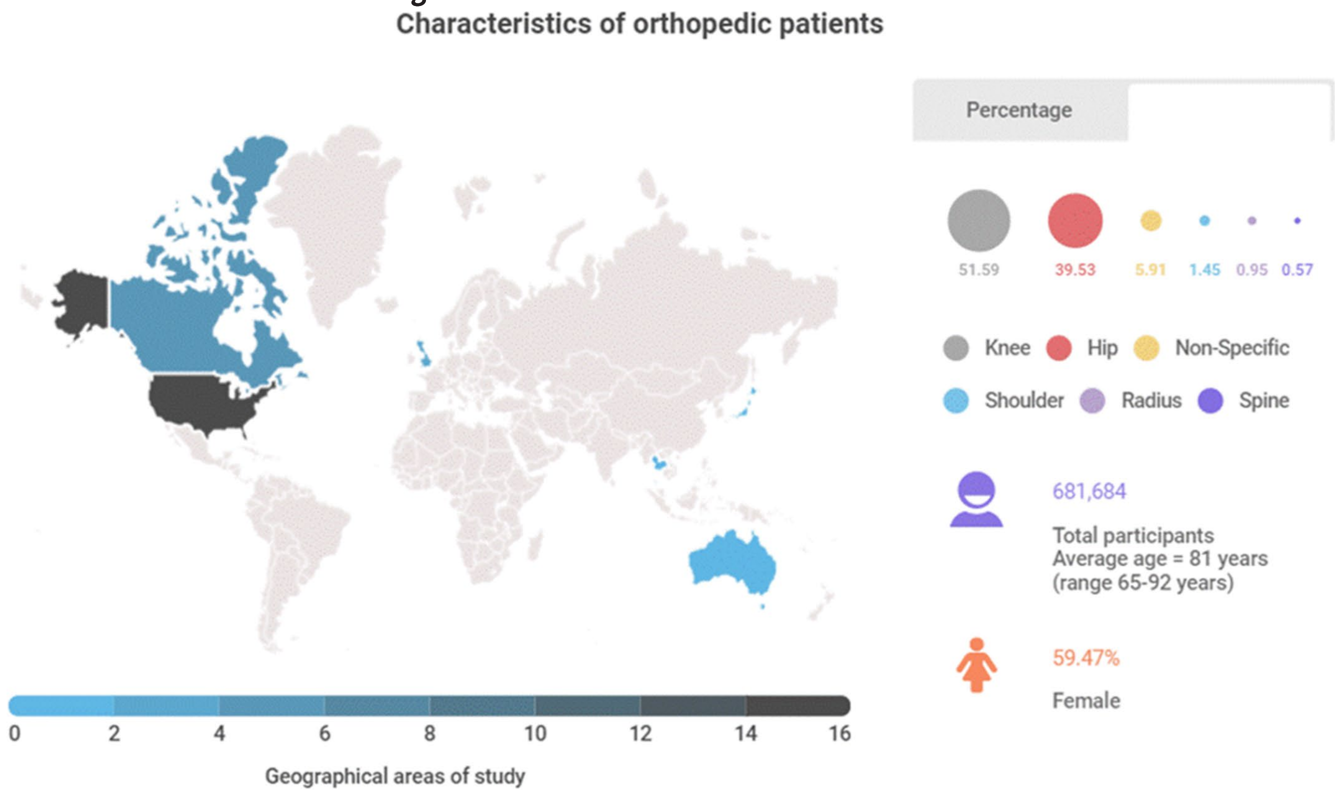

FIGURE 2 Characteristics of orthopaedic patients and geographical locations of studies [Colour figure can be viewed at wileyonlinelibrary.com]

to MSK conditions may increase the time to complete a frailty evaluation, especially one that involves physical performance. Hospitals should be concerned about fostering early detection and screening for frailty as one means to promote health outcomes and control costs (Grimes et al., 2018; World Health Organization, 2017).

Third, focusing on the quality of instruments is significant in accurately detecting frailty. In our review, poor inter-rater reliability was discovered in several common frailty instruments: FP criteria and FI (Cooper et al., 2016). The poor inter-rater reliability indicated a difference in the judgment of frailty in orthopaedic patients. These findings echo previous literature findings that musculoskeletal ageing phenotype or clinical symptoms interfere with the accuracy of frailty evaluation (Dasgupta et al., 2009; Kistler et al., 2015; Krishnan et al., 2014; Kua et al., 2016) and confirm overlap of frailty and disability (Fried et al., 2001, 2004). In an ageing society, MSK conditions are a significant health problem, so frailty identification is needed to promote health and equity. Our findings are consistent with a recent systematic review of frailty instruments on the most instruments used in acute care (Theou et al., 2018). Despite the research into frailty having a long history, possibly two decades, there remains a paucity of evidence on frailty instruments in diverse geographical areas. As most instruments integrate self-report in measuring frailty, clear communication is of concern (Fick & Lundebjerg, 2017). Promoting effective frailty screening through translation and cultural adaptation across different settings will promote health equity.

5 | REVIEW LIMITATIONS

This review had several limitations. First, it only considered studies in English. Second, based on the search terms and selection criteria used, some relevant studies might have been missed, such as emergency orthopaedic surgery and surgery for bone tumour/sarcoma and adults less than 65 years of age. Another source of limitation is due to some health databases were not included for identifying research articles. However, we are confident that the findings provide helpful evidence on frailty instruments used for hospitalised older adult orthopaedic patients.

6 | CONCLUSIONS

Early screening for frailty in the preoperative period is essential to prognosticate negative outcomes and provide better care in hospitalised older adults undergoing orthopaedic surgery. Current frailty instruments may be useful in inpatient orthopaedic settings, although evidence is lacking for the best frailty measure to use. Considerations when selecting a frailty instrument include clinical context, resource requirement, instrument quality and cultural sensitivity. Applying frailty screening in regular preoperative care or training family members to monitor frailty trajectories may enhance health outcomes. Future research that explores the feasibility and acceptability of incorporating family members into frailty assessment and using frailty instruments in hospital settings is crucial for providing equity and quality of care for all older adults.

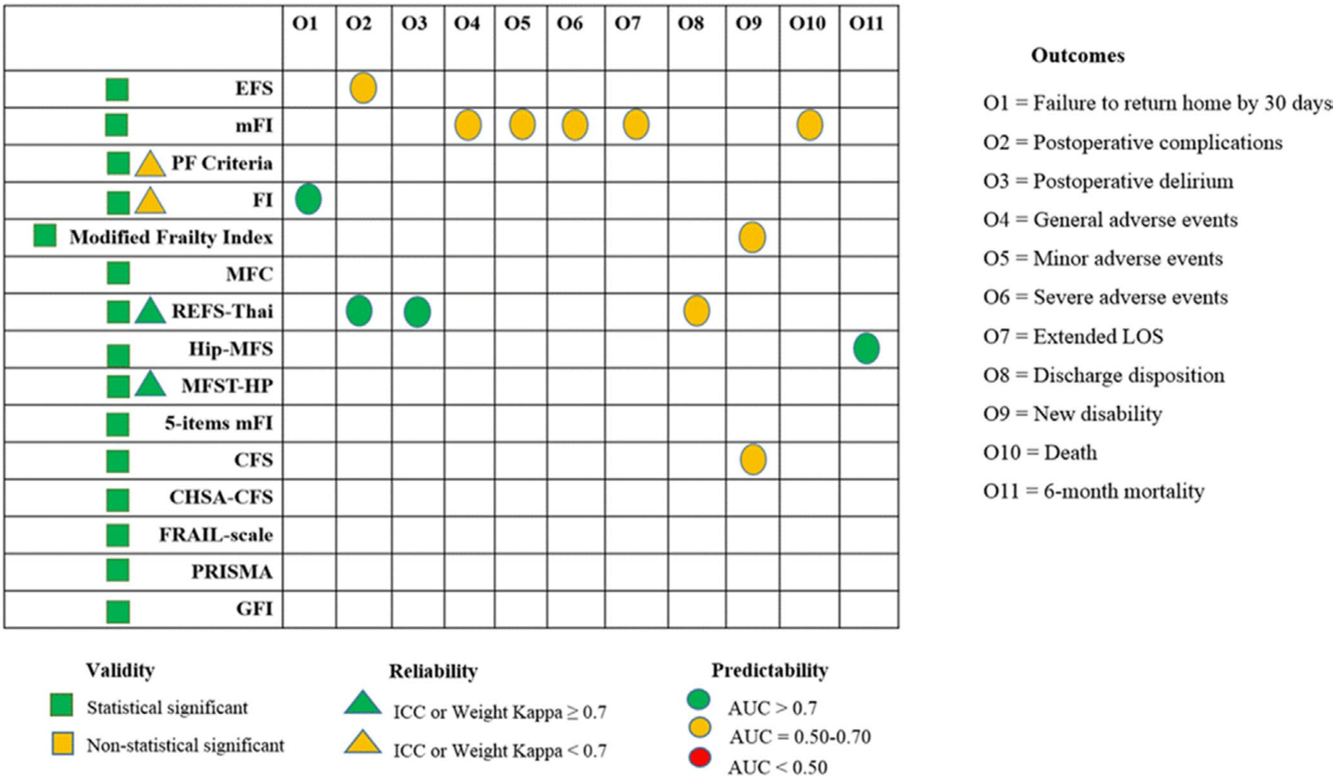

FIGURE 3 Quality of frailty instruments used in orthopaedic patients [Colour figure can be viewed at wileyonlinelibrary.com]

7 | RELEVANCE TO CLINICAL PRACTICE

The clinical spectrum of musculoskeletal manifestations in orthogeriatric patients may bias frailty classification. Proactive care and early identification of frailty in this population are more challenging yet are essential in promoting optimal health outcomes in hospital settings. Routine frailty screening with a practical and valid instrument is crucial to strengthen preoperative risk stratification for improving surgical care in older adults. Ultimately, specific or modified instruments may be needed for accurately identifying frail older adults who have physical limitations, which is concordant with the core clinical presentation of frailty.

ACKNOWLEDGEMENTS

Inthira Roopsawang received funding support from Ramathibodi School of Nursing, Faculty of Medicine Ramathibodi Hospital, Mahidol University, Thailand; and the de Tornyay Center for Healthy Aging, University of Washington, Seattle.

CONFLICT OF INTEREST

All authors have no conflicts of interest to disclose.

AUTHOR CONTRIBUTION

Study design: IR, OZ, HT and BB; Implementation of the search strategy: IR, OZ and SA; Analysis of the results: IR, OZ and SA; Writing of the manuscript: IR, OZ, HT, SA, BB and RK.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

How to cite this article: Roopsawang, I., Zaslavsky, O., Thompson, H., Aree-Ue, S., Kwan, R. Y. C., & Belza, B. (2022). Frailty measurements in hospitalised orthopaedic populations age 65 and older: A scoping review. *Journal of Clinical Nursing*, 31, 1149–1163. https://doi.org/10.1111/jocn.16035