



Frailty Assessment Tools for Adults with Obesity: A Scoping Review

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Abstract

Purpose To identify, classify, and compare available tools for frailty assessment in adults with obesity.

Methods A scoping review was conducted across five databases, including grey literature searches and an ascendancy approach. Seventeen studies were included, with a total sample size of 4,953,011 participants, of whom 4,931,181 were adults with obesity (99.56% of the total sample). Data on sample characteristics, assessment tools, and outcomes were extracted.

Results The most common methodological approach was comorbidity-based instruments, used in 9 of the 17 included studies (52.9%), followed by syndrome-based instruments (4/17; 23.5%), performance-based instruments (2/17; 11.8%), and population-specific instruments (2/17; 11.8%). Among the ten instruments identified, the Frailty Index (FI) was the most frequently used.

Conclusion There are ten different instruments for frailty assessment in adults with obesity, they are heterogeneous and mainly focus on comorbidity-related aspects. Currently, none of the instruments, methods, or tools identified in this review comprehensively captured the multidimensional nature of frailty in this population.

Key Points

- The Frailty Index is the most used frailty assessment tool for adults with obesity.
- Most frailty assessment tools were originally developed for older adults, which limits their applicability to other age groups.
- Current frailty assessment tools for adults with obesity primarily focus on comorbidities, based on the accumulation of multidimensional deficits model.
- Recent assessment tools specifically developed for adults with obesity undergoing bariatric and metabolic surgery (BMS) have emerged.

Keywords Frailty · Obesity · Screening Tools · Multidimensional

Introduction

Frailty is a multidimensional condition, most widely conceptualized as either a syndrome or a clinical state [1, 2]. As a syndrome, it primarily comprises physical aspects such as weakness, slow gait, low endurance, low levels of physical activity, and unintentional weight loss [1, 3]. As a clinical state, is the burden of coexisting multidimensional deficits, and the context and the severity of these multiple deficits can threaten survival [2]. Even though frailty is not automatically the same as having multiple diseases or being disabled, assessment instruments help identify individuals with or at risk of having this condition, thereby guiding targeted interventions.

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It is often regarded as a geriatric condition, but increasing evidence shows that frailty is not exclusive to the elderly [4]. Frailty and pre-frailty are increasingly recognized in adults, particularly in the presence of chronic conditions, associated with multimorbidity, sedentary lifestyle, or other risk factors, one of them being obesity [4, 5]. Recognition of frailty profiles between adults and in early stages is clinically important because it can guide preventive interventions and reduce adverse outcomes and long-term healthcare burdens [4–6].

As obesity prevalence continues to rise globally across all age groups, understanding the context of frailty and obesity is crucial for advancing its assessment and management. However, there is still no consensus in the literature regarding which instruments are most appropriate for assessing frailty syndrome specifically in adults with obesity and most frailty screening instruments were originally developed for the general older population, which may underestimate frailty for these individuals [7–9].

Therefore, a comprehensive review of the methods used to assess frailty in adults with obesity is warranted, exploring their applicability, validity, and limitations. Accordingly, this scoping review aims to identify, classify, and compare available tools for frailty assessment in adults with obesity.

Methods

Protocol and Registration

The review protocol was developed following the Joanna Briggs Institute guidelines [10, 11] and the PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses – extension for Scoping Reviews) recommendations, and was registered on the Open Science Framework [12, 13].

The review was conducted in five stages: (1) identification of the research objective and eligibility criteria, (2) identification and selection of relevant studies, (3) data extraction, (4) data synthesis, and (5) presentation of results.

Research Objective and Eligibility Criteria

The study question was formulated using the PCC framework: (P) population – adults with obesity; (C) concept – frailty screening and diagnosis; (C) context – not restricted. The review aims to comprehensively map the methods, procedures, and instruments used for screening and diagnosing frailty syndrome in individuals with obesity.

Inclusion criteria comprised studies assessing frailty using structured instruments with published operational criteria in adults aged 18–59 years with obesity, published

up to March 09, 2026, with no language restrictions. Studies were eligible if participants met a recognized definition of obesity (e.g., BMI ≥ 30 kg/m² or equivalent clinical classification), or if obesity-specific results could be extracted from the total sample. Eligible studies were included if the reported mean age fell within this range or if the study explicitly restricted inclusion to participants younger than 60 years of age.

Exclusion criteria include studies lacking adequate diagnostic criteria for obesity, or those that do not describe the methods, procedures, or instruments for frailty assessment.

Study Identification and Selection

Based on the PCC framework, the search strategy was developed and refined in consultation with an academic librarian to ensure adequate sensitivity and coverage of the literature. Controlled vocabulary and free-text keywords were combined and adapted for each database (Supplementary Digital File 1).

To assess the sensitivity of the search strategy, preliminary searches identified a benchmark set of 15 relevant studies that were treated as “anchor” references. Recall was initially assessed for each database, with refinement of the search strings when necessary. This process ensured that the final search query had maximal sensitivity before being applied to the full database. Subsequently, overall recall was calculated using a combined-search criteria based on the records retrieved across all databases [(number of benchmark articles retrieved/15)*100] [14, 15].

Searches were simultaneously conducted in PubMed, EBSCO, Web of Science, Embase, and Scopus, supplemented by grey literature (Google Scholar). Through the ascendancy approach, references cited by included studies were assessed to identify additional relevant research not captured through the initial database search.

The selection of potentially eligible references was performed in two stages, by two independent reviewers using the software Rayyan[®], with the resolution of conflicts afterward by a third reviewer [16].

Data Extraction

Studies were eligible for data extraction if the reported mean age of the sample fell between 18 and 59 years. For studies reporting multiple groups, data was extracted from the subgroup that met the eligibility criteria (i.e., participants with obesity within the specified age range). Microsoft Excel 2016[®] was used for data extraction and charting. Information extracted included study identification (authors, year, journal), sample characteristics (setting, sample size, sex distribution, age, body weight, obesity measures and

obesity class), and frailty assessment characteristics (instrument objective, clinical context, methodological approach, application setting, materials used, and cutoff points).

Included studies were categorized into three predefined groups according to the characteristics of the study population and the availability of obesity-specific data: (1) obesity-exclusive studies, in which the sample comprised only adults with obesity; (2) mixed-population studies with obesity-specific estimates, including heterogeneous samples but reporting results stratified by obesity status or providing sufficient information to allow extraction of obesity-specific data; and (3) instrument-mapping-only studies, included exclusively for the purpose of describing frailty assessment instruments, without obesity-specific outcome estimates. This categorization does not reflect a judgment regarding study quality.

For studies in the instrument-mapping-only category, only the characteristics of the frailty instrument were extracted, whereas sample size, frailty prevalence, and outcome data were not extracted and did not contribute to any aggregated denominator. Aggregated sample sizes reported in this review therefore refer exclusively to studies in groups (1) and (2).

Data presented as a percentage was converted to absolute numbers and the data presented by gender or group was transformed for the whole sample by pondered mean. Data extraction was performed by two reviewers.

Data Synthesis

Outcome-related synthesis was restricted to groups (1) and (2), to avoid extrapolation beyond obesity-specific evidence. Studies in group (3) contributed solely to the descriptive mapping of frailty instruments and were not included in any interpretation of clinical associations.

For descriptive purposes, participants were operationally classified into two age groups: young adults (18–39 years) and middle-aged adults (40–59 years).

Frailty assessment tools were categorized into four groups according to their primary methodological approach: performance-based instruments, which rely on objective physical testing; comorbidity-based instruments, which quantify frailty through the accumulation of chronic conditions and functional deficits; syndrome-based instruments, which conceptualize frailty as a phenotype defined by the presence of multiple physical criteria; and population-specific instruments, which are tailored to particular clinical populations or care contexts and incorporate domains relevant to those groups.

A descriptive bibliometric overview was conducted using the *Bibliometrix* package in R (version 4.3.1). Annual

scientific production and growth rate were automatically calculated by the software based on publication year using default parameters.

Results Presentation

Findings were presented in tables and graphs [17], with discussion within the context of existing literature and relevant theoretical and methodological frameworks addressing frailty and obesity.

Results

Search Outcomes

The search in the databases identified 3308 references. After the screening of 2333 references, 2291 were excluded, 2228 (98%) for wrong population and 63 (3%) for wrong outcome. Out of the remaining 42 references, 9 were not retrieved, and 33 studies were assessed for eligibility. After eligibility assessment, 18 references were excluded (89% for wrong population and 11% wrong outcome), and 15 studies were included in the review, which accounted for 88% of all the included studies.

Additionally, manual search identified 220 references, from which 181 were excluded for wrong population. Out of the remaining 39, 7 were not retrieved and 32 studies were assessed for eligibility, with the exclusion of 30 references (76% for wrong outcome, 13% for wrong outcome and 1% for wrong publication type) and the inclusion of 2 references, which accounted for 12% of all the included studies. For the result, 17 studies were included in the review with 96% of alignment between reviewers (Fig. 1).

For sensitivity assessment, the combined search across databases retrieved 14 of the 15 benchmark studies (93%). The remaining study was identified through grey literature searching, resulting in a final combined recall of 100%. These findings indicate that the final search strategy achieved full coverage of the benchmark references.

Study Identification and Characteristics

The included studies were published between 2012 and 2025, with five studies (29.4%) published in 2023 (Fig. 2). Annual growth in scientific output averaged 8.82%. Most studies were conducted in the USA (65%), followed by China (12%). The remaining studies were conducted in Japan, Finland, Jordan, and Ireland (Fig. 2). All the included studies were published in English. Most of the included studies were published in journals related to surgery and

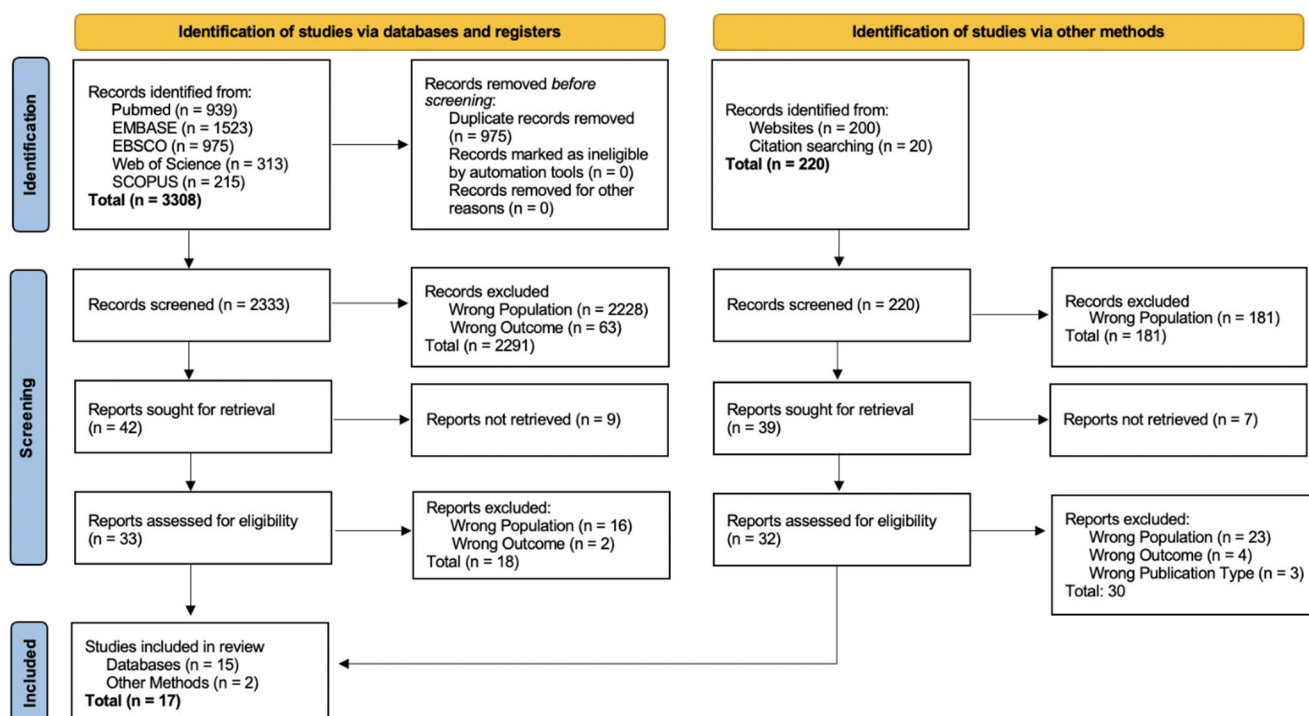
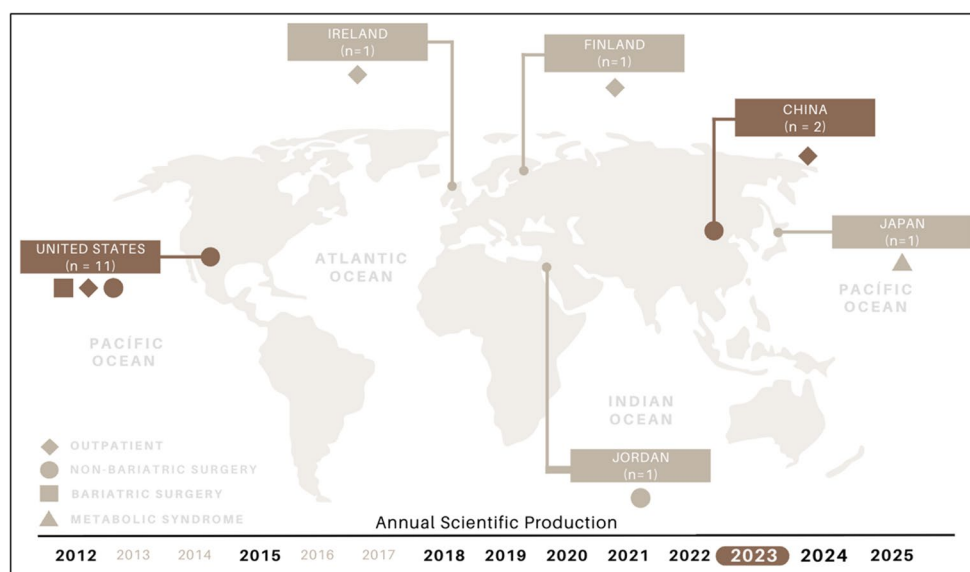


Fig. 1 Prisma flow diagram source: Adapted from Page MJ, et al. BMJ 2021;372:n71. <https://doi.org/10.1136/bmj.n71>

Fig. 2 Annual scientific production with geographic disposition. Source: Created by the authors using Canva



obesity (47%); other scopes were diabetes (17%), oncology (12%), rehabilitation (6%), clinical practice (6%), affective disorders (6%), and multiple sclerosis (6%) (Table 1).

According to the predefined classification, the 17 included studies were distributed as follows: seven (41%) were obesity-exclusive, predominantly in bariatric surgery or specialized obesity care settings; and ten (59%) were mixed-population studies with obesity-specific estimates, including heterogeneous clinical or population-based samples in which obesity was analyzed using BMI or other

adiposity indicators. No studies were included solely for instrument-mapping purposes.

Only estimates derived specifically from participants with obesity were considered for outcome-related synthesis. Studies providing methodological information contributed to the description of instruments, domains, and assessment approaches but were not used to interpret associations between frailty and clinical outcomes unless obesity-specific estimates were available. This classification was used to ensure that outcome-related statements were based on

Table 1 Studies characteristics

Author	Country, Year	Study Type, Sample Type	Journal Of Publication	Total sample Size (% of obesity)	Sample Origin, Gender (%)	Sample Age (mean±SD, mean or range)	Obesity Parameter (class)
Strandberg et al. [18]	Finland, 2012	Longitudinal, Mixed-population	International Journal of Obesity	1125 (100%)	Initially Healthy Men with Midlife Obesity and CVD Risk, 100% Male	Total Sample** 48±0.2 years (Middle-aged)	BMI (class not reported)
Kolbe et al. [19]	USA, 2015	Retrospective cohort, Obesity-exclusive	Obesity Surgery	104,952 (100%)	Bariatric surgery patients, 79% female	Total Sample 45 years (Middle-aged)	BMI (Class III)
Tuttle et al. [20]	USA, 2018	Observational, Obesity-exclusive	Canadian Journal of diabetes	105 (100%)	Outpatient Obesity Management, 62% Male	Total Sample 57 years (Middle-aged)	BMI (Class I)
Haugen et al. [21]	USA, 2019	Longitudinal, Mixed-population	JAMA Surgery	1108 (100%)	Liver Transplant Candidates, 58% Male	Total Sample 55 years (Middle-aged)	BMI (Class I)
Mullen et al. [22]	USA, 2020	Retrospective cohort, Mixed-population	Gynecologic Oncology	163 (100%)	Gynecologic Surgery, 100% Female	Total Sample 57 years (Middle-aged)	BMI (Class II)
Rhynehart et al. [23]	Ireland, 2021	Observational, Obesity-exclusive	Frontiers in Rehabilitation Science	713 (100%)	Adults with complex obesity, 65% Female	Total Sample 44±11 years (Middle-aged)	BMI (Class III)
Hayajneh et al. [24]	Jordan, 2022	Observational, Mixed-population	International Journal of Clinical Practice	220 (100%)	Elective or urgent Cardiac Catheterization, 73% Male	Total Sample 49±11 years (Middle-aged)	Weight, WC, HC, WC/HC, WHtR, BSI, BAI, NA
Haight et al. [25]	USA, 2023	Observational, Mixed-population	Gynecologic Oncology	374 (100%)	Hysterectomy Patients, 100% Female	Total Sample 57 years (Middle-aged)	BMI (Class III)
Owodunni et al. [26]	USA, 2023	Retrospective cohort, Mixed-population	International Journal of Obesity	149,163 (100%)	Spinal Surgery, 52% Male	Total Sample 58 years (Middle-aged)	BMI (Class I)
Vadlakonda et al. [27]	USA, 2023	Retrospective cohort, Mixed-population	Surgery	20,099 (32%)	Oncologic Surgery, 56% Female	Obesity Group 49,3±9.4 (Middle-aged)	BMI (Class I)
Nishida et al. [28]	Japan, 2023	Cohort, Mixed-population	Obesity Science & Practice	3,958,708 (100%)	Adults with metabolic syndrome, 61% Male	Total Sample 34–59 years (Young and Middle-aged)	BMI (class not reported)
Zhu et al. [29]	China, 2023	Observational, Mixed-population	Journal of Affective Disorders	11,503 (59%)	Cardiometabolic and Abdominal Obesity, 52% Female	Obesity Group 59±9.05 years (Middle-aged)	WC (class not reported)
Ebadinejad et al. [30]	USA, 2024	Observational, Obesity-exclusive	Surgical Endoscopy	1574 (100%)	Bariatric Surgery patients, 79% Female	Total Sample 45±12 years (Middle-aged)	BMI (Class III)
Kumar et al. [31]	USA, 2024	Observational, Obesity-exclusive	Multiple Sclerosis and Related Disorders	76 (100%)	Outpatient Obesity Management, 82% Female	Total Sample 47±10.9 years (Middle-aged)	BMI (Class II)
Zhang et al. [32]	China, 2025	Observational, Obesity-exclusive	Diabetology & Metabolic Syndrome	5,790 (41%)	Diabesity with Peripheral Neuropathy, 52% Female	Total Sample** 58±8.53 years (Middle-aged)	BRI (class not reported)

Table 1 (continued)

Author	Country, Year	Study Type, Sample Type	Journal Of Publication	Total sample Size (% of obesity)	Sample Origin, Gender (%)	Sample Age (mean $\pm$ SD, mean or range)	Obesity Parameter (class)
Chang et al. [33]	USA, 2025	Observational, Obesity-exclusive	Surgery for Obesity and Related Diseases	693,066 (100) %	Bariatric surgery patients, NA	Total Sample 44 $\pm$ 11 years (Middle-aged)	BMI (Class III)
Zhan et al. [34]	USA, 2025	Observational, Mixed-population	Diabetology & Metabolic Syndrome	6598 (*)	Adults with overweight and Obesity, 49% Female	Total Sample** 47 $\pm$ 0.29 years (Middle-aged)	BMI (Class II)

The table summarizes the study, country and year of publication, journal, sample size and type, gender distribution, mean age, and obesity parameter/class. NA indicates information not available. *BMI*=body mass index; *WC*=waist circumference; *HC*=hip circumference; *WHtR*=waist-to-height ratio; *BSI*=body shape index; *BAI*=body adiposity index; *BRI*=body roundness index; *CVD*=cardiovascular disease. *The total sample size is reported; however, the percentage of participants with obesity could not be determined, as this data was not disaggregated in the original study. **Sample age for total sample, stratified sample size not available

evidence specific to adults with obesity rather than extrapolated from heterogeneous populations [15, 24].

The studies assessed frailty primarily at baseline and examined its associations with physical outcomes (falls and functional performance), health-related outcomes (metabolic syndrome, diabetes, peripheral neuropathy, cardiovascular–kidney–metabolic syndrome, cardiometabolic multimorbidity, sleep quality and liver transplant), postoperative outcomes, and obesity-related parameters (Table 2).

Most studies (53%) focused on pre- or postoperative care, while 35% addressed obesity or obesity-related clinical management. Additionally, 6% involved healthy adults, and 6% focused on the clinical management of other clinical conditions. Most studies used observational designs (53%), primarily cross-sectional clinical analyses. Retrospective cohort studies based on large clinical or surgical databases accounted for 29% of the included studies. Prospective longitudinal studies represented 12%, while population-based cohort studies accounted for 6%. Across longitudinal and retrospective cohort studies, frailty was assessed at baseline (preoperative or at study entry), with clinical outcomes ascertained during follow-up, whereas cross-sectional studies evaluated frailty and outcomes concurrently, without temporal ordering (Table 2).

Earlier studies (2012) focused on cardiovascular risk profiles, anthropometry, postoperative adverse outcomes, risk scores, and mortality. From 2015 onwards outcomes became more diverse, comorbidity-focused indices were increasingly used, while syndrome-based instruments were introduced in subsequent years, integrating chronic disease history, functional dependence, and other domains into frailty assessment.

Sample Characteristics

From the 17 included studies, sample sizes ranged from 105 to 3,958,708 participants. The total study population

comprised 4,953,011 participants, of whom 4,941,181 met the predefined age and obesity-related eligibility criteria and constituted the analytic sample. All included studies met the predefined age criterion based on either a reported participant age range of 18–59 years or a mean participant age $\leq$ 59 years. Sixteen studies (94.1%) reported mean participant ages between 40 and 59 years, equally distributed between mean ages of 40–49 years (47.1%) and 50–59 years (47.1%). One study reported participant age range (34–59 years), without providing the mean age or age-stratified outcomes. Although most samples were middle-aged, bariatric cohorts tended to be younger (mean age 44–46 years), whereas gynecologic, oncologic, cardiovascular, and transplant-related cohorts were older (mean age 55–59 years) (Table 1). None of the studies exclusively enrolled adults aged 18–39 years; therefore, evidence specific to young adults could not be examined. Therefore, the available evidence predominantly reflects middle-aged adults. Because individual-level age distributions were not consistently reported, studies meeting the mean-age criterion may have included a subset of participants aged $\geq$ 60 years.

Sex distribution varied substantially by clinical context: women predominated in bariatric and gynecologic studies (65–100%), whereas men predominated in cardiovascular and metabolic cohorts (61–100%). Obesity severity ranged from class I to class III, with the highest BMI observed in bariatric cohorts.

Although studies met a standard obesity definition, additional anthropometric measures beyond BMI were frequently reported, including waist and hip circumference, waist-to-hip ratio (WHtR), Body Roundness Index (BRI), Body Adiposity Index (BAI), and Body Shape Index (BSI). Cardiometabolic comorbidities, Obstructive Sleep Apnea (OSA), and dyslipidemia were common. Samples were stratified by frailty status, associated medical problems, body composition, and surgical type or outcomes (Table 1).

Table 2 Frailty assessment tools

Author	Frailty Assessment Instrument	Purpose of Frailty Assessment	Methodological Approach	Cutoff Point	Proportion of Frailty	Instrument Limitations
Strandberg et al. [18]	Modified Cardiovascular Health Study Index	Association between frailty, obesity and CVD risk	Syndrome-Based	Non-frail = 0; Pre-frail = 1–2; Frail ≥ 3	Frail: 9% Pre-frail: 50%	Only physical domain; self-reported measures.
Kolbe et al. [19]	Modified Frailty Index (mFI-11)	Impact of frailty in surgical outcomes	Comorbidity-based	NA	NA	Based on clinical records; Does not capture psychosocial aspects.
Tuttle et al. [20]	Modified 9-item Physical Performance Test (mPPT)	Impact of frailty in physical function	Performance-Based	Frail ≤ 19	Frail: 30–61%	Only physical domain; Requires in-person assessment.
Haugen et al. [21]	Liver Frailty Index (LFI)	Impact of frailty and obesity on mortality risk	Performance-Based	Robust < 3.2 ; Pre-frail = 3.2–4.4; Frail ≥ 4.5	Frail: 27%	Only physical domain; Disease-specific.
Mullen et al. [22]	Modified Frailty Index (mFI-11)	Association between frailty, BMI and wound healing after Gynecologic surgery	Comorbidity-based	Non-frail < 2 ; Frail ≥ 2	Frail: 34%	Based on clinical records; Does not capture psychosocial aspects.
Rhynehart et al. [23]	Modified Fried Frailty Phenotype	Association between frailty, obesity and MS	Syndrome-based	<i>Male – Frail:</i> HG < 28 kg GS < 0.9 m/s <i>Female – Frail:</i> HG < 18 kg GS < 0.8 m/s	Frail: 3.4%	Only physical domain; Requires instruments.
Haya-jneh et al. [24]	Tilburg Frailty Indicator (TFI)	Association between frailty and obesity	Syndrome-based	Frail ≥ 5	Frail: 27%	Self-reported.
Haight et al. [25]	Modified Frailty Index (mFI-11)	Impact of frailty on total hospital stay after surgery	Comorbidity-based	Frail ≥ 2	Frail: 37%	Based on clinical records; Does not capture psychosocial aspects.
Owo-dunni et al. [26]	Risk Analysis Index (RAI) Modified Frailty Index (mFI-5)	Impact of frailty in mortality after surgical procedure	Administrative risk score/Comorbidity-based	<i>RAI:</i> Robust = 0–20; Typical = 21–29; Frail = 30–40; Very Frail ≥ 41 <i>mFI-5:</i> Frail ≥ 1	Frail: 0.2% Very Frail: 0.03%	<i>RAI</i> Requires multiple clinical inputs, limited applicability beyond surgical settings. <i>mFI-5</i> Based on clinical records; Does not capture psychosocial aspects; Fewer variables may reduce sensitivity to detect frailty.

Table 2 (continued)

Author	Frailty Assessment Instrument	Purpose of Frailty Assessment	Methodological Approach	Cutoff Point	Proportion of Frailty	Instrument Limitations
Vadlakonda et al. [27]	Modified Frailty Index (mFI-5)	Impact of frailty in surgical outcomes	Comorbidity-based	Frail ≥ 1	Frail: 79%	Based on clinical records; Does not capture psychosocial aspects; Fewer variables may reduce sensitivity to detect frailty.
Nishida et al. [28]	Hospital Frailty Risk Score (HFRS)	Association between frailty, obesity and MS	Administrative risk score (Comorbidity-based)	<i>Risk of Frailty:</i> Low < 5 ; Intermediate = 5–15; High > 15	High Risk of Frailty: 0.2% Moderate Risk of Frailty: 6.4%	Does not capture psychosocial aspects; Based on clinical records.
Zhu et al. [29]	Modified Fried Frailty Phenotype	Impact of frailty on cardiometabolic health	Syndrome-based	Frail ≥ 3 criteria	Frail: 1.4%	Only physical domain; Does not capture cognitive or psychosocial aspects.
Ebadinejad et al. [30]	Bariatric Frailty Score (BFS)	Impact of frailty on total weight loss after BMS	Population-specific	Frail ≥ 3	Frail: 50%	Developed for bariatric population; lacks external validation; Based on clinical records.
Chang et al. [33]	Bariatric Frailty Index (BFI)	Impact of frailty in surgical outcomes	Population-specific	Non-frail = 0; Pre-frail = 1–2; Frail ≥ 3	Frail: 10% Pre-frail: 56%	Developed for bariatric population; lacks external validation; Based on clinical records.
Zhang et al. [32]	32-Item Frailty Index (FI)	Association between frailty, obesity and CKM syndrome	Comorbidity-based	Frail ≥ 25	Frail: 34%	Based on clinical records; Requires extensive clinical data.
Kumar et al. [31]	41-item Frailty Index (FI)	Association between frailty and sleep	Comorbidity-based	Frail ≥ 0.25	Frail: 32%	Requires extensive clinical data. May not capture dynamic physical performance.
Zhan et al. [34]	49-item Frailty Index (FI)	Association between METS-VF and frailty	Comorbidity-based	Frail ≥ 0.25	Frail: 13%	Requires extensive clinical data; Does not directly assess physical performance.

The table summarizes the study, frailty assessment instrument, objective of frailty assessment, methodology, cutoff points, prevalence of frailty, and limitations reported in each study. *CVD*=cardiovascular disease; *HG*=handgrip; *GS*=gait speed; *BMS*=bariatric metabolic surgery; *MS*=metabolic syndrome; *CKM*: Cardiovascular-Kidney-Metabolic; *METS-VF*: metabolic score for visceral fat

To further examine the conceptual framing of frailty in young and middle-aged adults, a sensitivity synthesis was conducted including only studies with a mean participant age ≤ 50 years. Within this subgroup, the frailty assessment approaches and clinical contexts were consistent with those observed in the broader sample, with modified Frailty Index variants and performance-based instruments predominating. Associations reported between frailty and adverse clinical or metabolic outcomes were also directionally similar to those observed in the broader evidence base. These findings

suggest that the observed patterns were not driven exclusively by studies comprising older cohorts.

Overview of Assessment of Frailty

Frailty assessment was most often used as a preoperative tool to explore management efficacy, adverse outcomes, physical function, overall health status, and prognosis in the context of complex obesity. Across the included studies, ten unique instruments were identified (Table 2). Among the

17 included studies, comorbidity-based instruments were the most frequently used methodological approach (9/17; 52.9%), followed by syndrome-based instruments (4/17; 23.5%), performance-based instruments (2/17; 11.8%), and population-specific instruments (2/17; 11.8%). The Frailty Index (FI) was the most frequently used individual instrument among the tools identified in this review.

The methodological approaches varied according to the complexity of the frailty instrument, the characteristics of the target population, and whether direct physical testing was feasible. Starting in 2012, earlier studies in frailty in adults with obesity used self-reported criteria based on the accumulation of deficits or objective performance-based measures based on physical manifestations of the Fried frailty model.

From 2015 to 2020 onwards, comorbidity-focused indices and syndrome-based instruments were introduced, integrating chronic disease history with functional dependence to classify frailty status, respectively. More recent studies (2024–2025) reinforced the predominant use of the Frailty Index and its modified variants, while also incorporating population-specific instruments. Developed primarily for the bariatric surgery populations, these tools encompassed physical, cognitive, and clinical domains, aiming to capture the multidimensional nature of frailty in adults with obesity in surgical settings.

A wide range of assessment procedures and data sources were used, depending on the instrument and assessment approach. Instruments used one or more of the following: dynamometers for handgrip strength, chairs for sit-to-stand tests, stairs for climbing tasks, self-report questionnaires, and data from national or multicenter databases obtained retrospectively or prospectively. There was considerable heterogeneity in cutoff points and frailty classification according to the assessment method. Performance-based instruments often used absolute thresholds, such as handgrip strength or timed walking tests, whereas syndrome-based instruments classified participants according to the number of criteria met.

Syndrome-based questionnaires classified participants as frail if they met a specific number of criteria, while pre-frail or non-frail/robust categories were defined according to fewer criteria. Comorbidity-based indices defined frailty using cumulative deficit scores; frail individuals exceeded a predefined score or number of health conditions. Finally, population-specific adaptations included tailored cutoffs to stratify participants as robust, pre-frail, or frail.

Across the included studies, frailty was generally associated with worse clinical outcomes, including longer hospital stay, postoperative complications, mortality, and greater cardiometabolic risk. In cross-sectional analyses, reported associations reflect concurrent relationships rather than

temporal effects. These observational findings are likely influenced by associated health conditions, disease severity, and selection into high-risk clinical pathways, limiting exchangeability even after statistical adjustment.

All associations reported reflect observational associations, with frailty assessed at baseline in longitudinal and retrospective cohorts or concurrently with outcomes in cross-sectional studies and should not be interpreted as causal effects.

The measurement properties of the identified instruments were described based on the evidence reported in the included studies. These findings were interpreted cautiously, as the primary aim of this scoping review was to map the instruments rather than systematically evaluate their measurement properties.

Frailty Assessment Tools

Modified Cardiovascular Health Study Index

The modified Cardiovascular Health Study (CHS) index was the performance-based instrument used to assess frailty in one longitudinal 26-year follow up study involving an all-men sample and cardiovascular disease published in 2012. Derived from the Fried frailty model, this construct was based on four out of the five physical manifestations (weakness, slowness, exhaustion, low activity, and unintentional weight loss), with methodological adaptations.

Shrinking (1) was defined as weight loss (percentage from midlife or having current calculated BMI under 21); (2) physical weakness was based on self-reported difficulty in carrying or lifting a grocery bag (part of Physical function scale of RAND-36); (3) exhaustion was based on reported low energy most of the time during the preceding 4 weeks (part of Vitality scale of RAND-36); and (4) physical inactivity was based on a question: ‘Do you exercise regularly weekly?’ The answer ‘No’ was taken to denote physical inactivity. For this instrument, the cutoff points were scores 3–4 for frail, scores 1–2 for pre-frail and scores 0 for non-frail [17].

Regarding measurement properties, previous studies have demonstrated construct and predictive validity of the Cardiovascular Health Study (CHS) frailty phenotype in older adult populations. However, evidence regarding the measurement properties of modified CHS definitions in adults with obesity remains limited, particularly with respect to reliability and responsiveness.

Frailty Index

The Frailty Index (FI) was the most frequently used assessment tool in the included studies. Several studies assessed

frailty using frailty indices composed of 36, 41, and 49 health deficits, as well as modified versions ranging from 5 to 11 items. Conceptually, the FI is based on the accumulation of health deficits, including associated medical problems and functional or other health-related impairments.

Different versions of the FI were applied across the included studies, primarily in surgical cohorts and, more recently, in the contexts of chronic clinical conditions (cardiovascular-Kidney-Metabolic syndrome and Multiple Sclerosis). In addition, recent population-based analyses applied FI using large epidemiological datasets, where deficit accumulation models are particularly suitable given the structure of routinely collected variables.

Studies published in 2015, 2020, and 2023 used the Modified Frailty Index (mFI), incorporating either 11 variables (mFI-11) or 5 variables (mFI-5) related to functional status and chronic conditions.

The variables included in the mFI-11 are (1) functional status, (2) history of diabetes mellitus, (3) history of chronic obstructive pulmonary disease or pneumonia; (4) history of congestive heart failure; (5) history of myocardial infarction; (6) history of percutaneous coronary intervention, stenting, or angina; (7) history of hypertension requiring medication; (8) history of peripheral vascular disease or ischemic rest pain; (9) history of transient ischemic attack or cerebrovascular event, (10) history of cerebrovascular accident with neurologic deficit, and (11) history of impaired sensorium.

The mFI-5 includes: (1) congestive heart failure, (2) chronic obstructive pulmonary disease, (3) hypertension, (4) diabetes requiring medication, and (5) functional independence.

Each variable was scored as present or absent, although cutoff definitions varied between studies. For the mFI-5, scores ≥ 1 indicated frailty [26, 27]. For the mFI-11, the cutoff points were either: (1) frail for scores ≥ 2 and non-frail for scores < 2 ; or (2) robust for 0 as score, typical for scores ≥ 1 , frail for scores ≥ 2 , and very frail for scores ≥ 3 [19, 22, 25].

In contrast, more recent studies, published in 2024 and 2025, applied the extended FI, which may include 32, 41, or 49 items. Across these approaches, FI scores were calculated as the proportion of health deficits present relative to the total number of deficits assessed,

In the 32-Item Frailty Index (32-FI), 32 items spanning physical function, cognitive health, and chronic conditions, some continuous (0–1) and other binary (0=no deficit, 1=deficit) [35]. The score was the sum of deficits, divided by 32, multiplied by 100 [35]. The 32-FI scores range from 0 to 100; frailty was defined as scores ≥ 25 , and higher scores indicate greater frailty [35].

In the 41-Item Frailty Index (41-FI), 41 items spanning physical function, comorbidities, cognition, sexual and

psychosocial function identified through subjective and objective measures. Each domain was scored, some ordinal (0=absence or 1=maximal expression of the deficit), some binary (0=absence or 1=presence) and some continuous (cut-off thresholds). The score was the sum of deficits, divided by the total number of available deficit items, with a minimum of 30 deficit items its recommended for reliable estimation of frailty index. For the 41-FI, frailty was defined as scores ≥ 0.25 [31].

In the 49-Item Frailty Index (49-FI), 49 items from multiple health domains, spanning from cognitive function, functional dependence, depressive symptoms, chronic illnesses, medical history, recent hospitalization, self-rated health, anthropometric and laboratory parameters. The 49-FI score was the ratio of current health deficits to the total number of items assessed (0=no deficits; 1=maximum deficits), with $\geq 80\%$ item completion as the minimum to ensure validity. For the 49-FI, frailty was defined as an FI ≥ 0.25 .

Regarding measurement properties, previous studies have demonstrated construct validity, reliability, and predictive performance of the Frailty Index across clinical and population-based settings, including populations with obesity. However, evidence regarding responsiveness, particularly in bariatric populations, remains limited [22, 25–27].

Modified 9-item Physical Performance Test

The Modified 9-item Physical Performance Test (mPPT) is a performance-based tool to assess frailty in an observational study exploring diabetes and obesity in a clinical setting published in 2018. The mPPT comprised functional tasks such as walking, stair climbing, chair rises, and object manipulation related to activities of daily living. Each item is scored from 0 to 4 based on the time (in seconds) to complete each task. Each task was performed twice with the average time used to score the task.

The study applied a scoring range of 0 to 36, with lower scores reflecting poorer physical performance. The cutoff point for frailty was scored ≤ 19 . For this instrument, frailty prevalence was 30% for individuals with diabetes and 61% for individuals with both diabetes and peripheral neuropathy (DMPN) [20].

Regarding measurement properties, previous studies have reported evidence of construct validity and reliability for the mPPT in clinical and surgical populations. However, evidence regarding its responsiveness and predictive performance specifically in adults with obesity remains limited.

Liver Frailty Index

The Liver Frailty Index (LFI) was the performance-based instrument used to assess frailty in a prospective study in

an out-patient setting for patients with chronic liver disease, published in 2019. The LFI incorporated three objective measures: grip strength, chair stands, and balance testing. The LFI score was calculated using a software by a formula with sex-adjusted grip strength, number of chair stands per second, and balance time. Standard cutoffs points were: LFI score < 3,2 for robust, LFI score of 3,2 to < 4,5 for pre-frail and LFI score $\geq$ 4,5 for frail, with higher values indicating greater frailty.

For this instrument, frailty prevalence was 27% overall, with a modest increase from class I (26%) to class II obesity (29%) [21]. In liver transplant candidates, baseline frailty was associated with a higher risk of risk, with stronger effects observed among those with higher BMI [21].

Regarding measurement properties, previous studies have demonstrated construct validity, high inter-rater reliability, responsiveness, and strong predictive performance of the LFI in patients with chronic liver disease and liver transplant candidates. However, the extent to which these measurement properties generalize to adults with obesity outside liver transplant settings remains uncertain.

Modified Fried Frailty Phenotype

The modified version of the Fried Frailty Phenotype operationalized frailty in two studies with retrospective data published in 2021 and 2023. This instrument conceptualized frailty as a syndrome, with criteria based on five physical manifestations.

A study with cardiometabolic multimorbid patients modified the phenotype to reflect the bariatric context, including only two of the five clinical manifestations: handgrip strength (HG) assessed with a dynamometer and gait speed (GS). Sex-specific cutoffs were used for each variable: HG < 28 kg and GS < 0.9 m/s for men, and HG < 18 kg and GS < 0.8 m/s for women. Participants below the established thresholds for both measures were classified as frail.

A longitudinal nationwide survey (China Health and Retirement Longitudinal Study [CHARLS]) modified the phenotype to reflect the physical and cognitive frailty. For physical frailty, BMI for shrinking, handgrip strength test for weakness, 2.5 m gait speed or the chair stand test for slowness, two items (7 and 20) of the 10-item Center for Epidemiological Studies Depression Scale (CESD-10) for exhaustion and the self-reported waking time in a week for low physical activity. Participants who met three or more criteria were defined as having physical frailty. Cognitive frailty was defined as the simultaneous presence of both cognitive impairment and physical frailty [29].

Regarding measurement properties, previous studies have demonstrated construct and predictive validity of the Fried frailty phenotype and its adaptations in older

and clinical populations. However, evidence regarding the measurement properties of modified Fried phenotypes specifically in adults with obesity remains limited, particularly with respect to reliability and responsiveness [20, 21].

Tilburg Frailty Indicator

The Tilburg Frailty Indicator (TFI) was a screening tool for frailty in one observational study with coronary artery disease patients undergoing cardiac catheterization, published in 2022. The TFI is syndrome-based 15-item, multidimensional, self-reported questionnaire that assess frailty across three domains: physical (8 items), psychological (4 items), and social (3 items). Scoring ranged from 0 to 15, and for this instrument, the cutoff points for frailty was scores $\geq$ 5. For this instrument, the prevalence of frailty was 27% [16, 24].

Hospital Frailty Risk Score

The Hospital Frailty Risk Score (HFRS) assessed frailty in a large cohort study with data from hospital settings, published in 2023. This administrative risk scores operationalized frailty as a deficit accumulation model based on associated medical problems and healthcare utilization, according to 109 specific International Classification of Diseases (ICD-10) codes from conditions common in frail individuals including neurological diseases, cognitive impairment, mobility issues, falls, and nutritional deficiencies. Each condition is assigned a weighted point value ranging from 0.1 to 7.1; total score is calculated by summing the points for all relevant code found. The HFRS was calculated retrospectively from the data obtained, scoring categorized individuals as low risk (< 5), intermediate risk (5–15), or high risk (> 15) of frailty. Higher scores indicate a greater risk of frailty [29, 29].

Risk Analysis Index

The Risk Analysis Index (RAI) was used to assess frailty in a study that compared the discriminatory thresholds of RAI, mFI-5, and age for postoperative mortality, published in 2023. This administrative risk score is a deficit accumulation model based on demographic information, functional independence, and clinical factors. Each variable ranges from 0 to 1; total score is the sum of all points. Total score ranges from 0 to 81, with the following cutoff points: robust (0–20), typical (21–29), frail (31–40), and very frail ($\geq$ 41). The RAI demonstrated superior discrimination for adverse outcomes compared with age and the mFI-5. Baseline frailty, as classified by the RAI, was more strongly associated with severe postoperative complications than age or alternative frailty

indexes [26]. From the older individuals of the sample, approximately 0.2% were frail [26].

Regarding measurement properties, previous studies have demonstrated good criterion validity, reliability, and strong predictive performance of the RAI for postoperative morbidity and mortality in high-risk surgical populations. However, evidence regarding its responsiveness to change remains limited.

Bariatric Frailty Score

The Bariatric Frailty Score (BFS) was the instrument used to assess preoperative frailty in a single-centered retrospective study with individuals from a BMS center, published in 2024. BFS is a population-specific tool designed to capture frailty in candidates for bariatric surgery. It integrates (1) functional status, (2) history of type 2 diabetes mellitus, (3) history of chronic obstructive pulmonary disease, (4) history of myocardial infarction, (5) previous cardiac surgery, Percutaneous Coronary Intervention (PCI) or Percutaneous Transluminal Coronary Angioplasty (PTCA), (6) hypertension requiring medication, (7) obstructive sleep apnea requiring Continuous Positive Airway Pressure (CPAP) or Bilevel Positive Airway Pressure (BiPAP), (8) Use of mobility device, (9) Deep vein thrombosis, pulmonary embolism or venous insufficiency, and (10) Body mass index ≥ 50 kg/m². Scores ranged from 0 to 10, with frailty defined as scores ≥ 3 .

Regarding measurement properties, previous studies have reported promising predictive performance of the BFS for short-term postoperative outcomes following bariatric surgery. However, evidence regarding its construct validity, reliability, and responsiveness remains limited.

Bariatric Frailty Index

The Bariatric Frailty Index (BFI) is the population-specific instrument that operationalized preoperative frailty in a retrospective study with individuals from a BMS center, published in 2025. BFI is a deficit accumulation model tailored to bariatric populations, based on 14 variables from the Canadian Study of Health and Aging-Frailty Index (CSHA-FI). It comprises (1) functional status, (2) mobility, (3) history of myocardial infarction, (4) history of diabetes, (5) preoperative history of COPD, oxygen dependent, or preoperative obstructive sleep apnea; (6) previous PCI/PTCA or previous cardiac surgery, (7) preoperative hypertensive requiring medication; (8) preoperative Gastroesophageal Reflux Disease (GERD) requiring medication; and (9) preoperative renal insufficiency or on dialysis. Each variable ranges from 0 to 1; total score is the sum of all points.

Regarding measurement properties, previous studies have reported predictive performance of the BFI in bariatric cohorts. However, evidence regarding its construct validity, reliability, and responsiveness remains limited.

For these instruments, cutoff points were scored 0 for not frail, scores 1–2 for pre-frail and scores > 3 for frailty [33].

Table 3 summarizes the domains and components of frailty captured by each instrument, highlighting differences in construct coverage, dimensionality, and the way individual components are operationalized. Across instruments, physical function and comorbidity or disease burden were the most frequently represented domains, although they were assessed using different approaches, including direct performance measures, self-reported information, and administrative proxies. Cognitive and psychosocial domains were less frequently incorporated, and population-specific components were mainly observed in instruments developed for clinical contexts, such as bariatric surgery and hospital-based populations.

Discussion

This scoping review mapped evidence from 17 studies examining tools used to assess frailty in adults with obesity. Frailty was most commonly assessed preoperatively to inform risk stratification, management strategies, and prognosis. Over time, it has gained increasing relevance across diverse clinical and research contexts.

The original and modified Frailty Indexes were the most frequently used assessment instruments across these studies, applied in diverse clinical contexts including surgical, metabolic, and epidemiologic populations. Overall, these findings indicate that frailty assessment is both feasible and clinically meaningful in adults with obesity and that frailty status was consistently associated with clinical outcomes across settings, with instruments increasingly refined and adapted over time. However, the context in which these instruments were applied varied across studies, which may affect the comparability of the estimates reported.

The distribution of studies across analytical categories highlights an important characteristic of the current literature. While several studies were conducted in populations exclusively composed of individuals with obesity, the majority were performed in heterogeneous clinical populations in which obesity was analyzed as a risk factor rather than the primary population of interest. This pattern suggests that research on frailty in obesity is often conducted within broader clinical contexts, which may affect both the interpretation and comparability of frailty assessments across studies.

Table 3 Summary matrix of frailty assessment tools

Author	Frailty assessment instrument	Physical function	Comorbidity/ Disease burden	Cognitive function	Psychosocial aspects	Population- specific context
Strandberg et al. [18]	Modified Cardiovascular Health Study Index	Partially capture	Absent	Absent	Absent	Absent
Kolbe et al. [19]	Modified Frailty Index (mFI-11)	Administrative Proxy	Administrative Proxy	Absent	Absent	Absent
Tuttle et al. [20]	Modified 9-item Physical Performance Test (mPPT)	Directly Measured	Absent	Absent	Absent	Absent
Haugen et al. [21]	Liver Frailty Index (LFI)	Directly measured	Absent	Absent	Absent	Absent
Mullen et al. [22]	Modified Frailty Index (mFI-11)	Administrative Proxy	Administrative Proxy	Absent	Absent	Absent
Rhynehart et al. [23]	Modified Fried Frailty Phenotype	Directly measured/self-reported	Absent	Absent	Absent	Absent
Hayajneh et al. [24]	Tilburg Frailty Indicator (TFI)	Self-reported	Absent	Absent	Self-reported	Absent
Haight et al. [25]	Modified Frailty Index (mFI-11)	Administrative Proxy	Administrative Proxy	Absent	Absent –	Absent
Owodunni et al [26]	Risk Analysis Index (RAI)	Administrative Proxy	Administrative Proxy	Absent	Absent	Absent
Owodunni et al [26]	Modified Frailty Index (mFI-5)	Administrative Proxy	Administrative Proxy	Absent	Absent	Absent
Vadlakonda et al [27]	Modified Frailty Index (mFI-5)	Administrative Proxy	Administrative Proxy	Absent	Absent	Absent
Nishida et al [28]	Hospital Frailty Risk Score (HFRS)	Administrative Proxy	Administrative Proxy	Administrative Proxy	Absent	Administrative Proxy
Zhu et al [29]	Modified Fried Frailty Phenotype	Directly Measured	Absent	Absent	Absent	Absent
Ebadinejad et al [30]	Bariatric Frailty Score (BFS)	Administrative Proxy	Administrative Proxy	Absent	Absent	Administrative Proxy
Chang et al [33]	Bariatric Frailty Index (BFI)	Administrative Proxy	Administrative Proxy	Absent	Absent	Administrative Proxy
Zhang et al [32]	32-Item Frailty Index (32-FI)	Administrative Proxy	Administrative Proxy	Administrative Proxy	Absent	Absent
Kumar et al. [31]	41-Item Frailty Index (41-FI)	Administrative Proxy	Administrative Proxy	Administrative Proxy	Administrative Proxy	Absent
Zhan et al. [34]	49-Item Frailty Index (49-FI)	Administrative Proxy	Administrative Proxy	Administrative Proxy	Administrative Proxy	Absent

“Directly Measured” refers to objective performance-based assessment; “Self-reported” refers to participant-reported information; and “Administrative Proxy” refers to domains inferred indirectly from clinical records, diagnostic codes, healthcare utilization, or routinely collected variables. “Absent” indicates that the domain was not represented in the operational definition of the instrument

Descriptive Overview of Observational Associations

Across included studies, frailty was operationalized at baseline in longitudinal and retrospective cohort designs, typically in preoperative or study-entry contexts (time zero), with outcomes assessed during predefined follow-up periods ranging from in-hospital events to long-term mortality. In cross-sectional studies, frailty and health outcomes were assessed concurrently, without temporal ordering.

In surgical cohorts, frailty was generally measured preoperatively and outcomes included postoperative complications, prolonged length of stay, non-home discharge, or short-term mortality. In cardiometabolic and epidemiologic studies, frailty status was examined in relation to metabolic syndrome, multimorbidity, or functional impairment.

All included studies were observational in design. Adjustment strategies varied substantially and residual confounding by multimorbidity, disease severity, healthcare

utilization, socioeconomic factors, and selection into high-risk clinical pathways is likely. Confounding by indication and reverse causation cannot be excluded, particularly in cross-sectional analyses. Therefore, all associations reported in the literature reflect statistical relationships within specific clinical contexts and should not be interpreted as evidence of causality.

Frailty Assessment Tools

Historically, frailty assessment in this population started with self-reported criteria or performance-based instruments and focused on postoperative outcomes, cardiovascular health, and mortality. As the volume of BMS increased globally over the years, metabolic and age-related risk factors became more relevant, and preoperative risk-stratification tools expanded in scope, prompting the integration of frailty assessments into preoperative evaluation frameworks [36, 37].

Over the years, comorbidity-focused indices and more diverse outcomes, such as the overall burden of associated medical conditions and functional performance, have gained prominence. In the included studies, individuals with obesity who exhibited frailty frequently presented a multimorbid profile, dominated by metabolic, respiratory, and cardiovascular disorders, which may contribute to the heightened risks observed. Frailty assessment tools gradually evolved beyond surgical endpoints to emphasize multidimensional outcomes, introducing the assessment of psychosocial and cognitive domains. Importantly, these associations were derived predominantly from observational designs, with frailty assessed at baseline in longitudinal and retrospective studies or concurrently with outcomes in cross-sectional studies, which limits causal inference.

Table 3 summarizes the domains of frailty captured by each instrument and the approaches used to operationalize these domains. Physical function and comorbidity or disease burden were the most consistently represented components, although their assessment varied substantially across instruments, ranging from directly measured performance to self-reported information and administrative proxies. Cognitive and psychosocial domains were less frequently represented, while population-specific components were primarily incorporated into instruments developed for bariatric, hospital-based, or other specialized clinical settings. This heterogeneity highlights important differences in construct coverage across instruments and supports the need to consider the intended purpose and target population when selecting a frailty assessment tool. Beyond domain coverage, previous studies have reported varying levels of evidence regarding the measurement properties of the identified instruments. Evidence for construct validity and

predictive performance is available for several established frailty instruments, particularly in older or disease-specific populations, whereas evidence regarding reliability and responsiveness is less consistently reported. Importantly, evidence for the measurement properties of an instrument does not necessarily originate from populations with obesity. Several instruments were originally developed or validated in older or disease-specific populations, and these properties may not automatically generalize to adults with obesity, particularly younger adults.

This broadening focus in assessment tools aligns with recently reported evidence on the association of non-physical factors, such as demographic and socioeconomic variables, with postoperative outcomes following bariatric procedures [38]. Although frailty assessment in these individuals has primarily been conducted in hospital-based, preoperative settings aimed at surgical outcomes, our findings highlight a progressive shift from purely biomedical, procedure-centered instruments toward a population-specific, multidimensional understanding of frailty.

For this purpose, ten different instruments were identified in this review, each originally developed for specific settings and populations. Most were originally developed or evaluated among community-dwelling older adults or in surgical cohorts [39–42]. Other instruments were developed or evaluated in hospital, clinical, and epidemiologic settings for specific populations, such as patients with liver disease, veterans, or bariatric surgery populations [1, 43–45].

Originally proposed for geriatric populations, the FI operationalizes frailty according to the accumulation of health deficits and was the most frequently used assessment instrument across these studies. However, the instruments differed substantially in the domains included and in how frailty was operationalized. Physical function and comorbidity burden were common components, whereas cognitive and psychosocial domains were less consistently represented. These differences in construct coverage are important when interpreting findings across instruments and clinical contexts. The FI and its modified versions were the most frequently used instruments to assess frailty in adults with obesity. This group of instruments was applied for risk stratification in different clinical contexts, with reported feasibility advantages, as they rely on routinely collected clinical data. Originally proposed for use in older populations, the FI operationalizes frailty according to the accumulation of health deficits and has demonstrated associations with adverse outcomes across a range of populations. Its feasibility and predictive performance have also supported its use in clinical and surgical risk stratification [46–49].

The Bariatric Frailty Index and the Bariatric Frailty Score were specifically developed for bariatric populations. The Bariatric Frailty Index adapts the cumulative

deficit framework to reflect obesity-specific health domains, whereas the Bariatric Frailty Score was subsequently reported to be associated with adverse postoperative outcomes [43]. Recent research suggests continued refinement for older bariatric patients with the Modified Bariatric Frailty Score (mBFS) [50].

Even though the bariatric-specific frailty instruments represent an important step toward contextualized risk stratification, they predominantly operationalize frailty through organ-specific comorbidities, functional dependence, and perioperative risk markers. These tools have been applied primarily to risk stratification for short-term surgical outcomes and postoperative complications, and their responsiveness to early or potentially reversible frailty states in younger adults with obesity was not reported in any of the included studies.

A conceptual limitation that cuts across several of the identified instruments concerns the boundary between frailty and obesity-related multimorbidity. Deficit-accumulation indices operationalize frailty as the proportion of health deficits present, and the deficit lists used in the included studies frequently incorporate type 2 diabetes, hypertension, obstructive sleep apnoea, functional dependence, healthcare utilization, and, in obesity-specific adaptations, anthropometric thresholds such as $\text{BMI} \geq 50 \text{ kg/m}^2$. Each of these is a highly prevalent feature of severe obesity itself. When such items are counted as frailty deficits in a population defined by obesity, the resulting score may partly re-express the comorbidity burden that characterizes the population rather than identifying a distinct state of physiological vulnerability and reduced reserve.

This has three consequences for interpretation. First, frailty prevalence estimates may be influenced by the extent to which comorbidity burden is incorporated into the index. Second, apparent predictive performance for postoperative outcomes may be partly attributable to the comorbidity content of the index rather than to frailty as such, since comorbidity burden is itself an established predictor of perioperative risk. Third, and most relevant to younger adults, indices dominated by chronic disease diagnoses may be less sensitive to potentially reversible components of frailty, since diagnostic items do not necessarily change in response to prehabilitation or functional interventions. The inclusion of anthropometric thresholds is particularly problematic, as it introduces circularity in a population selected on the basis of adiposity.

None of the included studies reported analyses distinguishing the contribution of comorbidity items from that of function-based items to frailty classification, nor evaluated the discriminant validity of frailty scores relative to established comorbidity indices in adults with obesity. Future instruments for this population should therefore keep frailty

deficits and comorbidity indicators conceptually and operationally separate, so that the two can be modelled independently rather than confounded within a single composite score.

Mental health, cognitive function, social vulnerability, and other non-physical domains remain underrepresented or absent in many frailty assessment tools. This pattern persists even in recent studies, which continue to operationalize frailty primarily through comorbidity burden and cumulative deficits, with limited assessment of psychosocial or functional dimensions, despite growing evidence that these factors are associated with vulnerability and adverse health trajectories in adults with obesity [51].

The instruments identified in this review are not interchangeable across purposes, and evidence supporting one use does not transfer automatically to another. At least four distinct purposes of frailty assessment can be distinguished. These purposes impose different measurement requirements. First, screening aims to identify early, sub-clinical, or potentially reversible frailty in community or ambulatory settings and requires sensitivity to small deficits and to change over time. Second, diagnosis seeks to classify frailty as a clinical syndrome according to explicit criteria and depends on content validity relative to an accepted construct. Third, prognosis concerns the estimation of medium- to long-term outcome probabilities and rests on discrimination and calibration in the population of interest. Fourth, perioperative risk stratification supports short-term decisions regarding surgical candidacy, informed consent, and perioperative planning and prioritizes feasibility and predictive performance for in-hospital or 30-day events.

These uses impose different measurement requirements. Reported predictive performance for postoperative complications does not constitute evidence that an instrument detects early or reversible frailty in younger adults with obesity. Deficit-accumulation and administrative indices derive much of their predictive signal from accumulated comorbidity, which is precisely the component least likely to be present, and least likely to be modifiable, in younger individuals. In the included studies, instruments were applied predominantly for perioperative risk stratification or prognosis within surgical and high-risk clinical cohorts; no included study reported evidence for screening or diagnostic use in younger, community-dwelling adults with obesity. The clinical utility of these instruments should therefore be restricted to the specific purpose for which evidence was reported.

Taken together, these findings suggest several design principles for future frailty instruments targeting younger and middle-aged adults with obesity. Such tools should be multidimensional rather than comorbidity-based;

sensitive to early, subclinical deficits; and capable of capturing dynamic and potentially reversible aspects of frailty. Core domains should extend beyond chronic disease burden to include muscle mass, muscle strength, sarcopenia and body composition, objective measures of physical performance, psychological well-being, cognitive function, and social and environmental context. This shift would align frailty assessment in obesity with prevention-oriented frameworks, emphasizing resilience and modifiable vulnerability rather than irreversible surgical risk.

Although frailty was consistently associated with adverse clinical outcomes across studies, these findings were derived from observational designs and should be interpreted with caution. Residual confounding remains likely, given the close interrelationship between frailty, multimorbidity, disease severity, and healthcare utilization. Confounding by indication may also be present, as individuals identified as frail are more likely to be selected into high-risk clinical pathways, undergo more intensive monitoring, or experience delays to intervention. In addition, reverse causation cannot be excluded, particularly in cross-sectional analyses, where underlying disease burden or impending adverse outcomes may contribute to frailty classification rather than result from it.

The considerable heterogeneity across instruments, together with the modest differences in predictive performance reported in the few studies that compared tools directly, suggest that, for adults with obesity, cross-contextual evaluation and the selection of population- and context-specific instruments may be more critical for clinical practice than standardized assessment alone, particularly given residual confounding and limited exchangeability inherent in observational settings.

Moreover, given the importance of early identification for timely intervention, non-binary instruments that stratify frailty across multiple levels may be conceptually better suited than binary tools, particularly considering the variability in clinical manifestations and potential reversibility of frailty profiles in this population [6, 46, 47, 52]. This proposition follows from the conceptual structure of the instruments rather than from comparative measurement data, as no included study directly compared the responsiveness of binary and multilevel classifications in this population.

For adults with obesity, future frailty assessment tools should be multidimensional, incorporating biopsychosocial health markers, and designed to be low-burden and sensitive to early deficits, reflecting the limitations observed in the instruments used across the 17 included studies [37, 52, 53]. Advanced anthropometric and functional indices may refine prognostic models and identify high-risk subgroups for early intervention [4, 6, 52].

Limitations and Strengths

Most studies were constrained by retrospective or observational designs, potential selection bias, and highly specific clinical samples. Several commonly used instruments—particularly comorbidity-based indices and administrative frailty measures—relied on self-reported comorbidities, body weight, or diagnostic/procedure codes, which are prone to misclassification and residual confounding. In adults with obesity, these approaches may overestimate frailty by conflating multimorbidity and healthcare utilization with physiological vulnerability or underestimate early frailty when functional impairment is not assessed.

Additionally, muscle mass, dynapenia, sarcopenia, and body composition could not be consistently assessed as separate domains because sufficiently detailed and extractable information was not available across the included studies. This limitation may be particularly relevant in adults with obesity, in whom alterations in muscle mass and body composition may influence the identification and interpretation of frailty.

Performance-based tools requiring in-person testing were less frequently used and mostly limited to surgical or hospital settings, potentially excluding adults with mobility limitations or milder/subclinical frailty, and limiting applicability to community populations. Inconsistent reporting of key confounders—such as physical activity, diet, social determinants of health, and adherence to therapeutic protocols—further limits comparability across instruments.

Although this review targeted adults aged 18–59 years, the available evidence predominantly comprised middle-aged populations. None of the included studies reported a mean participant age below 40 years, exclusively enrolled adults aged 18–39 years or provided obesity-specific analyses stratified by younger age groups. Although one study included participants aged 34–59 years, age-specific outcomes were not reported. Therefore, evidence regarding frailty assessment in truly young adults with obesity remains scarce. Because individual-level age distributions were not consistently reported, some included studies may also have contained participants aged ≥ 60 years. Therefore, evidence regarding frailty assessment in young adults with obesity remains scarce. The complex clinical profiles of individuals with obesity and frailty may also reduce generalizability to younger adults, milder forms of obesity, or non-clinical populations. Evidence remains scarce in primary care, community, and low-resource settings. Additional heterogeneity in how adiposity was operationalized across studies also limits comparability. Finally, as this is a rapidly evolving field, very recent relevant studies may not have been captured.

The strengths of this review include a robust search strategy, rigorous selection process, and contextualized analysis, allowing comprehensive mapping of frailty assessment tools in adults with obesity and identification of key knowledge gaps across populations and settings. A key strength of this review is the systematically developed and benchmark-validated search strategy, refined with librarian support, which achieved full sensitivity (recall=100%) after inclusion of grey-literature sources.

Future research should prioritize prospective, longitudinal, and interventional studies conducted in ethnically, geographically, and socioeconomically diverse populations. Such studies should employ multidimensional frailty frameworks that integrate contextual, metabolic, functional, and psychosocial domains to better capture the complexity of frailty in adults with obesity.

Conclusion

Frailty assessment tools for adults with obesity are heterogeneous and predominantly focused on comorbidity-related aspects, frequently underrepresenting key domains such as cognitive function, psychosocial health, and broader functional capacity. No instrument identified in this review fully captured the multidimensional nature of frailty in this population. Current evidence supports context-specific frailty assessment in adults with obesity, particularly in surgical and other high-risk clinical settings, but does not establish a validated general screening instrument for young or community-dwelling adults with obesity.

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Data Availability No datasets were generated or analysed during the current study.

Declarations

Competing interests The authors declare no competing interests.

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