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REVIEW

Frailty detection by healthcare professionals: a systematic review of the available English and French tools and their validation

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Key summary points

Aim We aim to provide the most accurate data about frailty detection tools used by healthcare professionals.

Findings The number of criteria used by tools to detect frailty is broad and distributed in a total of nine different domains. There is a lack of homogeneity in the evaluation of the tools.

Message The great heterogeneity in the criteria and domains used to detect frailty and in the evaluation of the tools highlights a lack of strong recommendations for the creation, evaluation, and validation of frailty detection tools.

Abstract

Background There is a wide variety of frailty detection tools, but no gold standard. Choosing the most appropriate tool can therefore be complicated. Our systematic review seeks to provide useful data on the frailty detection tools available to help healthcare professionals in choosing a tool.

Method We systematically searched for articles published between January 2001 and December 2022 in three electronic databases. Articles were to be written in English or French and were to discuss a frailty detection tool used by healthcare professionals in a population without specific health conditions. Any self-testing, physical testing or biomarkers were excluded. Systematic reviews and meta-analyses were also excluded. Data were extracted from two coding grids; one for the criteria used by the tools to detect frailty and the other for the evaluation of clinimetric parameters. The quality of the articles was assessed using QUADAS-2.

Results A total of 52 articles, covering 36 frailty detection tools, were included and analysed in the systematic review. Forty-nine different criteria were identified, with a median of 9 (IQR 6–15) criteria per tool. Regarding the evaluation of tool performances, 13 different clinimetric properties were identified, with a mean of 3.6 (±2.2) properties assessed per tool.

Conclusion There is considerable heterogeneity in the criteria used to detect frailty, as well as in the way tools are evaluated.

Keywords Frailty · Screening · Evaluation tool · Older adults · Geriatric assessment

Introduction

Frailty is a clinical syndrome characterized by a subject's inability to respond adequately to a stress. This results in greater difficulty in recovering from a negative health event, with an increased risk of long-term care, hospitalisation and death [1–3]. A 2021 meta-analysis estimated that 18% of people aged ≥ 50 were frail and 45% pre-frail. However, the prevalence of frailty varies widely depending on the tool and definition used, ranging from 8 to 58% [4]. With the rapid aging of the European population [5], an increase in the number of frail and prefrail people is expected. The detection of frailty, especially in the early stages, appears to be of paramount importance in order to set up preventive strategies [6–8]. But the main problem in this detection is the lack of consensus for a universally accepted definition of frailty, despite a definition proposed by the World Health Organization (WHO) in 2016 [9]. Moreover, there is neither a gold standard in the panel of tools that are available for detecting

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the syndrome, nor biomarkers consensus [10]. This problem leads to a great heterogeneity of tools and their performance evaluation [11].

Currently, two models are considered as the standard in the detection of frailty [12]. The first was developed by Linda Fried's team and is founded on the identification of a frail phenotype (FP), based on five items: weight loss, muscle weakness, shortness of breath on exertion, slowness, and low level of physical activity. Each of these items is explored according to a precise criterion. Three of the five items must be present to define a person as "frail". If 1 or 2 items are met, the person is defined as "pre-frail" [1]. This model focuses mainly on a physical analysis of the patient, which is its main flaw [13] because of the risk of having a lower estimation of the prevalence of frailty [4, 14]. The second model, often called frailty index (FI), was developed by Kenneth Rockwood's team and measures an accumulation of deficit. The model is not only based on physical characteristics, but also on psychosocial characteristics and consider comorbidities. The result is a number between 0 (no deficits) and 1 (all deficits) and is obtained by computing the ratio of deficits present to the total number of deficits being measured [15]. Both of those models are complementary. The FP, which is short and easy to use, will be more likely to be used for screening frailty, while the FI, derived from the Comprehensive Geriatric Assessment (CGA), has its place in the management and follow-up of patients [12].

Each tool has its pros and cons. It is therefore important to know them to make the best choice when assessing frailty [3, 12]. A systematic review was conducted with the aim of compiling a list of the different available tools and establishing which criteria are used to detect frailty. Secondary objectives were to highlight a potential predominance of criteria in the detection of frailty and to analyse which clinimetric properties were assessed by the tools.

Method

The systematic review is reported following the preferred reporting items for systematic reviews and meta-analyses (PRISMA) guidelines [16]. The review protocol has been registered in PROSPERO, an international register of systematic reviews (number CRD42022303511).

Search strategy and selection criteria

A systematic literature search was conducted on 9th January 2023 on three databases: PubMed, Scopus and Wiley Online Library with the keywords 'frailty', 'frail', 'frailness', 'frailty syndrome', 'pre-frailty', 'assessment', 'screening', 'detection', 'validation', 'evaluation', 'tool', 'instrument' and 'questionnary'. Google Scholar and the website clinicaltrials.gov were also consulted for the research of grey literature with the same search equation used for the databases (for the whole search strategy, see online resource 1). We searched for papers describing the development and/or the evaluation of tools able to detect frailty published between January 2001 and December 2022. The word "frailty" was not considered as a specific measurable state.

Eligible studies were prospective, retrospective, and cross-sectional studies, without restriction based on the study design. We excluded review articles and articles which were not written in French or English. The only condition for the population eligibility was that they had to be frail, without restriction of gender, age, or ethnicity. The tools included had to be able to detect a frailty patient and had to be used by a health care professional. Self-tests for frailty were therefore excluded. Any tool that aims to identify frailty in a specific population (e.g., carrier of a particular disease), based only on a physical test or that relies on biological data (or biomarkers), as well as any tool focused on intrinsic capacity were also excluded.

Data selection

Articles were selected by two independent researchers (JB and BC). The decisions of each researcher were blinded for the other. A first selection was made based the title and the abstract and did not have to be justified. The second selection was based on the content of the text. In this step, the exclusion of the article had to be justified. A third independent researcher (SP) solved disagreements. The whole selection was carried out on the web application Rayyan [17].

Quality assessment

The quality of the selected articles was assessed by two independent researchers (JB and BC) using the Quality Assessment of Diagnostic Accuracy Studies (QUADAS-2) [18]. Risk of bias and applicability of each study was assessed for the following domains: patient selection, conduct and interpretation of the index test (i.e. the assessed test), conduct and interpretation of the reference standard, and flow and timing (only for risk of bias). This assessment did not lead to the exclusion of articles.

Data extraction and analysis

The data was extracted by two independent readers (JB and BC). NVivo© software [19] was used to extract the data by coding. The coding was based on two analysis grids. The first was focused on the main objective of the systematic review, i.e. the different existing tools and the items they include and was constructed deductively by giving a code (a characteristic) to each item and then grouping the codes

into coherent domains. The second grid was focused on the secondary objective, i.e., on the rigour of the methodology used to create and validate the tools. Information on the evaluation of the clinimetric parameters (such as feasibility, sensitivity, specificity, construct validity, predictive ability), on the validation against another tool, on the methodology for creating the tools and on the socio-demographic data of the populations (number of patients, age, sex, and setting) were extracted with the help of this second gird. This allowed the operationalisation of the data collection. A consensus meeting was then be organised to deal with coding discrepancies and a third party (SP) was present to decide in case of disagreement.

Results

Figure 1 show the study flow diagram. A total of 8053 records (including 2765 duplicates) were identified through the three databases. Some 5014 records were excluded in the first selection and 222 others in the second selection. To the 52 included records were added two others from Google Scholar. Fifty-four articles published from January 2001 to December 2022 were finally included in the systematic review. We decided afterward to not include two articles [20, 21] because of the tool which was not constructed like the other tools, which made it too different to be compared.

Characteristics of the studies

Table 1 summarises the characteristics of the studies. English was the most used language for publications (50/52) [22–71]. The location of the studies was, however, more diverse, with a total of 18 different countries and one multicentre study [23]. The most common countries were France (14/52) [26, 33, 34, 41, 50, 53, 58, 60, 61, 65, 69, 71–73], the Netherlands (8/52) [32, 38, 44, 46, 47, 52, 54, 56] and Canada (5/52) [24, 30, 45, 49, 55]. The study population was mainly people living in the community (35/52) [22–26, 30, 32–35, 38–41, 43–47, 49, 50, 53–56, 58, 60, 61, 64, 65, 67–69, 71, 72], followed by patients from hospitals (14/52) [26, 28, 31, 36, 37, 48, 52, 57, 59, 62, 63, 66, 70, 73] and nursing homes (5/52) [27, 29, 42, 46, 51]. Two studies had a combined population setting: people from the community and a hospital for the first [26] and people from the community and a nursing home for the second [46].

Characteristics of the tools

A total of 36 tools were identified through the 52 included articles. Specific characteristics of the tools are presented in

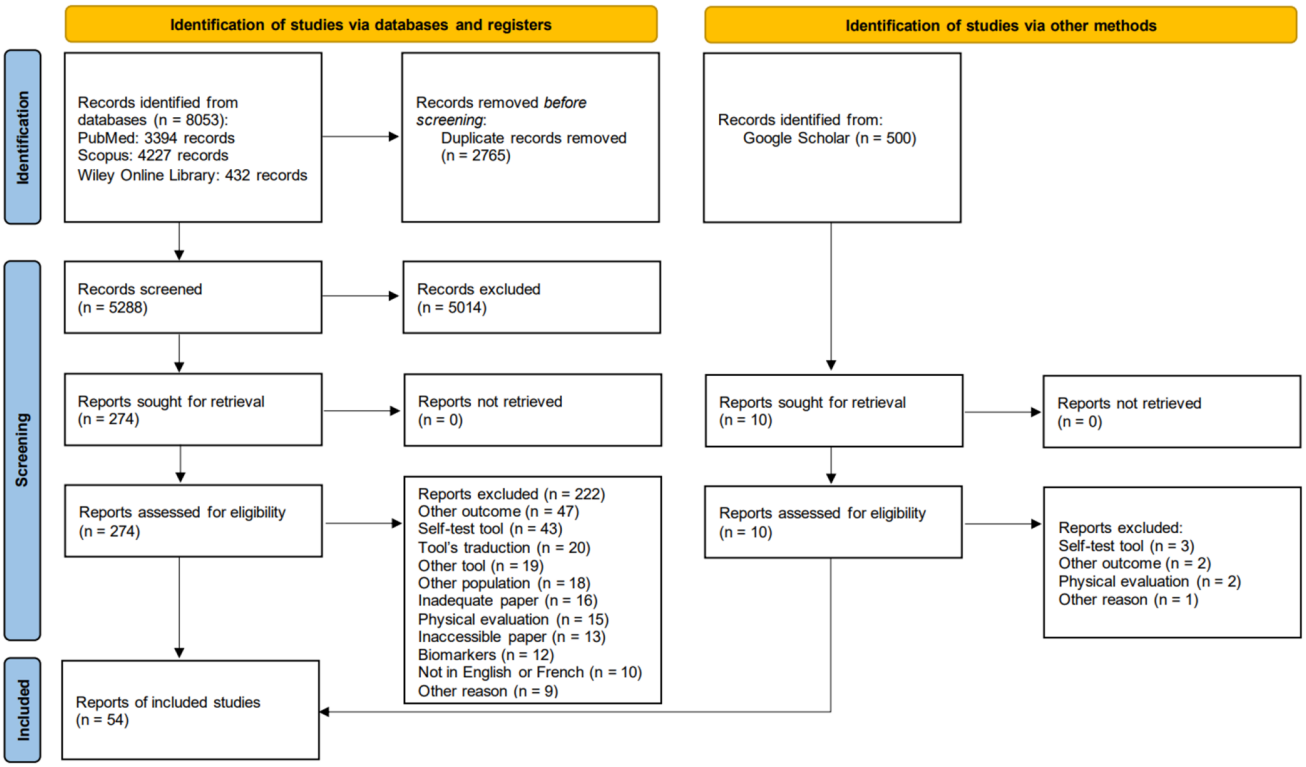

Fig. 1 Study flow diagram of the inclusion process. Adapted from: Page et al. [88]

Table 1 Descriptions of the studies and their characteristics: country, name of the tool studied, purpose, setting, number of patients included, their average age and the percentage of women

References	Country	Tool	Purpose	Settings	Patient number	Mean age (±SD)	% of women
Jones et al. [55]	Canada	FI-CGA	Outcome prediction + tool vs tool	Community	160	81.9 (±7.3)	57.5
Jones et al. [45]	Canada	FI-CGA	Outcome prediction + tool vs tool	Community	2305	84.5 (±6.7)	62.1
Rockwood [24]	Canada	CFS	Outcome prediction + tool vs tool	Community	2305	84.6 (±6.5)	61.9
Rolfson et al. [70]	Brazil	EFS	Tool vs tool	Hospital	158	80.4 (±6.8)	53
Chan et al. [66]	Taiwan	CFS TV	Tool vs tool	Hospital	67	Not available	51
Romero-Ortuno et al. [23]	Multicentred	SHARE-FI	Outcome prediction	Community	28,361	62.8 (±9.9)	54.9
Bielderman et al. [54]	Netherlands	GFI	Tool vs tool	Community	1508	75 (±7)	49.3
de Vries et al. [46]	Netherlands	EFIP	Tool vs tool	Nursing home + Community	24	78 (±7)	62.5
Keiren et al. [47]	Netherlands	EASY-Care TOS	Feasibility	Community	9	79	44.4
van Kempen et al. [44]	Netherlands	EASY-Care TOS	Development	Community	141	77 (±6)	62
van Kempen et al. [44]	Netherlands	EASY-Care TOS	Tool vs tool	Community	587	78 (±5)	56.2
Vellas et al. [53]	France	GFST	Tool vs tool	Community	442	Not available	Na
Oubaya et al. [61]	France	SEGAm	Tool vs tool	Community	167	77 (±7)	70.7
Tocchi et al. [42]	USA	FIFE	Development	Nursing home	312	Not available	77.6
Cherubini et al. [58]	France	GFST	Tool vs tool	Community	109	77.8 (±0.8)	66
van Kempen et al. [56]	Netherlands	EASY-Care TOS	Outcome prediction + tool vs tool	Community	520	76.7 (±4.8)	56.5
Diaz de León González et al. [67]	Mexico	FRAIL	Outcome prediction	Community	4729	67	53.4
Kaehr et al. [48]	USA	FRAIL-NH	Outcome prediction + tool vs tool	Hospital	270	Not available	75.5
Kajsa et al. [59]	Sweden	FRESH screening	Tool vs tool	Hospital	161	82 (±6)	55
Theou et al. [51]	Australia	FRAIL-NH	Tool vs tool	Nursing home	383	87.5 (±6.2)	77.5
Vernerey et al. [41]	France	FRAGIRE	Tool vs tool	Community	385	81.9 (±5.9)	83.1
Amalou et al. [73]	France	ABCDEF	Tool vs tool	Hospital	300	83	67.7
Fallon et al. [62]	Ireland	SHARE-FI	Outcome prediction	Hospital	198	78.8	51.5
Hoogendijk et al. [38]	Netherlands	LASA-FI	Outcome prediction	Community	2218	72 (±12)	Na
Kanters et al. [30]	Canada	FI-CLSA	Development	Community	20,874	Not available	51
Ludwig and Busnel [35]	Switzerland	FI-RAI	Outcome prediction	Community	3714	82.7 (±7.7)	67.7
Oubaya et al. [60]	France	SEGAm	Outcome prediction + tool vs tool	Community	116	76 (±7)	72.4
Feck and Zulfiqar [72]	France	SEGAm	Cluster comparison	Community	64	80 (±4)	58

Table 1 (continued)

References	Country	Tool	Purpose	Settings	Patient number	Mean age (±SD)	% of women
Ge et al. [27]	China	FRAIL-NH	Tool vs tool	Nursing Home	302	82.7 (±8.5)	71.2
Ge et al. [29]	China	FRAIL-NH	Tool vs tool	Nursing Home	302	82.7 (±8.5)	71.2
Kim et al. [43]	South Korea	FPQ	Tool vs tool	Community	2917	76	52.4
Lewis et al. [22]	Tanzania	B-FIT and B-FIT 2	Tool vs tool	Community	235	73	57.9
Maggio et al. [25]	Italy	SC	Tool vs tool	Community	95	81 (±4)	54
Warnier et al. [52]	Netherlands	VMS	Outcome prediction + tool vs tool	Hospital	2573	78.8 (±6.3)	51.8
Aznar-Tortonda et al. [36]	Spain	Frailty predictor	Tool vs tool	Hospital	621	73.1	58.8
Hoffmann et al. [57]	Denmark	PRISMA-7	Outcome prediction	Hospital	973	83 (±5)	58.6
Kotsani et al. [26]	France	LoFProS	Cluster comparison	Hospital + community	814	80 (±6)	59
Liguori et al. [64]	Italy	(fr)AGILE	Outcome prediction + tool vs tool	Community	401	77 (±7)	55.5
Moreno-Ariño et al. [31]	Spain	CFS	Tool vs tool	Hospital	184	80	59.2
Pérez-Zepeda et al. [49]	Canada	FI-CLSA	Descriptive statistics	Community	51,338	60.3	51.5
Saraiva et al. [28]	Brazil	AMPI-AB	Outcome prediction + tool vs tool	Hospital	317	80	67
De et al. [37]	India	FAST	Tool vs tool	Hospital	107	69 (±7)	39
Jung et al. [68]	South Korea	KFI and mKFI	Tool vs tool	Community	2886	76	52.4
Longobucco et al. [63]	Italy	SC	Tool vs tool	Hospital	235	81.7 (±7.0)	46.4
Shin et al. [39]	South Korea	KFS	Outcome prediction + Tool vs tool	Community	2923	76	52.2
Zulfiqar [33]	France	ZFS	Tool vs tool	Community	102	82	53.8
Zulfiqar [34]	France	ZFS	Tool vs tool	Community	102	76 (±8)	54
Zulfiqar [50]	France	sZFS	Tool vs tool	Community	107	74 (±7)	59.8
Zulfiqar [65]	France	sZFS	Tool vs tool	Community	268	77.5 (±7.8)	46.6
Ye et al. [40]	China	CFSS-10	Outcome predictive + tool vs tool	Community	2008	72.4 (±6.1)	53.3
Zulfiqar [69]	France	ZFS	Tool vs tool	Community	200	81.4 (±4.8)	51.5
Zulfiqar et al. [71]	France	ZFS	Tool vs tool	Community	124	79.1 (±3.6)	52

SD standard deviation, *AMPI-AB* multidimensional assessment of older people in primary care, *B-FIT* brief frailty instrument for Tanzania, *CFSS-10* Chinese Frailty Screening Scale, *CFS* clinical frail scale, *TV* telephone version, *TOS* two step older person screening, *EFIP* evaluative frailty index for physical activity, *EFS* edmonton frail scale, *FAST* frailty assessment and screening tool, *FI-CGA* frailty index derived for comprehensive geriatric assessment, *FI-CLSA* Frailty Index using the Canadian Longitudinal Study on aging, *FIFE* Frailty Index for elders, *FI-RAI* Frailty Index from the resident assessment instrument, *FPQ* Frailty Phenotype Questionnaire, *FRAGIRE* frailty GIR evaluation, *GFI* Groningen frailty indicator, *GFST* Gérontopôle frailty screening tool, *KFI* Korean Frailty Index, *KFS* Korean Frail Scale, *LASA-FI* Frailty Index in the Longitudinal Aging Study Amsterdam, *LoFProS* Lorraine frailty-profiling screening scale, *PRISMA* Program of Research to Integrate Services for the Maintenance of Autonomy, *SC* Sunfrail checklist, *SEGAm* short emergency geriatric assessment modified, *SHARE-FI* survey of health, ageing and retirement in Europe Frailty Index, *VMS* Dutch National Safety Management Program, *ZFS* Zulfiqar Frail Scale

Table 2. The range of the number of items was broad (from 2 to 52), with a median of 9 (inter-quartile range (IQR) 6–13) items per tool.

Quality assessment

No article was excluded based on its quality assessment results. The risk of bias was rather unclear for the index tests

Table 2 Description of the tool's characteristics: number of items, type of measurement scale and ability to detect pre-frailty

Tool's name	No. items	Scale type	Pre-frailty
(fr)AGILE	10	Ordinal scale: not, light, moderate and severe frail (range: 0–10)	Yes
ABCDEF	6	Dichotomous scale: not frail–frail (range: 0–6)	No
Multidimensional assessment of older people in primary care (AMPI-AB)	17	Ordinal scale: low, intermediate, or high (range: 0–17)	Yes
Brief frailty instrument for Tanzania (B-FIT)	2	Dichotomous scale: not frail–frail (range: 0–10)	No
Brief frailty instrument for Tanzania v2 (B-FIT 2)	5	Dichotomous scale: not frail –frail (range: 0–20)	No
Clinical frail scale (CFS)	9	Ordinal scale: from robust to complete dependence (range: 0–7)	Yes
Clinical frail scale telephone version (CFS TV)	6	Ordinal scale: from robust to complete dependence (range: 0–7)	Yes
Chinese frailty screening scale (CFSS-10)	10	Dichotomous scale: not frail–frail (range: 0–10)	No
EASY-Care two step older person screening (EASY-Care TOS)	14	Dichotomous scale: not frail–frail Subjective assessment of the healthcare professional	No
Evaluative frailty index for physical activity (EFIP)	50	Continuous scale: no cut-off point; high score equal to high frailty (range: 0–1)	No
Edmonton frail scale (EFS)	11	Ordinal scale: not, apparently, mild, moderate, or severe frail (range: 0–17)	Yes
Frailty assessment and screening tool (FAST)	14	Ordinal scale: robust, prefrail, or frail (range: 0–14)	Yes
Frailty Index derived for comprehensive geriatric assessment (FI-CGA)	11	Ordinal scale: From level 1 to level 7 (range: 0–1)	Yes
Frailty index using the Canadian Longitudinal Study on Aging (FI-CLSA)	52	Continuous scale: no cut-off point; high score equal to high frailty (range: 0–1)	No
Frailty index for elders (FIFE)	10	Continuous scale: cut-off for frailty at 4; high score equal to high frailty (range: 0–10)	No
Frailty index from the resident assessment instrument (FI-RAI)	52	Continuous scale: no cut-off point; high score equal to high frailty (range: 0–1)	No
Frailty Phenotype Questionnaire (FPQ)	5	Ordinal scale: robust, prefrail, or frail (range: 0–5)	Yes
Frailty GIR evaluation (FRAGIRE)	17	Continuous scale: no cut-off point; high score equal to high frailty (range: 0–100)	No
FRAIL scale	5	Ordinal scale: robust, prefrail or frail (range: 0–5)	Yes
FRAIL-NH	7	Ordinal scale: robust, frail, or high frail (range: 0–14)	No
Frailty predictor	5	Continuous scale: no cut-off point; high score equal to high probability to be frail (range: 0–100%)	No
FRESH screening	5	Dichotomous scale: not frail–frail (range: 0–5)	No
Groningen frailty indicator (GFI)	15	Continuous scale: cut-off for frailty at 4; high score equal to high frailty (range: 0–14)	No
Gérontopôle frailty screening tool (GFST)	6	Dichotomous scale: if score ≥ 1; subjective assessment of the healthcare professional (range: 0–6)	No
Korean frailty index (KFI)	8	Ordinal scale: robust, prefrail, or frail (range: 0–8)	Yes
Modified Korean frailty index modified (mKFI)	8	Ordinal scale: robust, prefrail, or frail (range: 0–8)	Yes
Korean frail scale (KFS)	6	Continuous scale: no cut-off point; high score equal to high frailty (range: 0–6)	No
Frailty Index in the Longitudinal Aging Study Amsterdam (LASA-FI)	32	Continuous scale: cut-off for frailty at 0,25; high score equal to high frailty (range: 0–1)	No
Lorraine frailty-profiling screening scale (LoFProS)	9	Categorization in 3 profiles: "absence of frailty", "physical frailty" or "cognitive/psychological frailty"	No
Program of Research to Integrate Services for the Maintenance of Autonomy (PRISMA-7)	7	Dichotomous scale: not frail—frail (range: 0–7)	No
Sunfrail checklist (SC)	9	Dichotomous scale: not frail—frail subjective assessment of the healthcare professional	No
Short emergency geriatric assessment modified (SEGAm)	13	Ordinal scale: mild, moderate, or severe frailty (range: 0–26)	No

Table 2 (continued)

Tool's name	No. items	Scale type	Pre-frailty
Survey of Health, Ageing and Retirement in Europe Frailty Index (SHARE-FI)	6	Ordinal scale: robust, prefrail or frail	Yes
Dutch National Safety Management Program (VMS)	4	Dichotomous scale: not frail–frail (range: 0–4)	No
Zulfiqar frail scale (ZFS)	6	Ordinal scale: robust, prefrail, or frail (range: 0–6)	Yes
Simplified Zulfiqar Frail Scale (sZFS)	5	Ordinal scale: robust, prefrail, or frail (range: 0–5)	Yes

(25/52) because it was often not mentioned if the tool was used before the reference test or without knowing the results. This problem was even more pronounced for the reference test, for which only nine out of 52 studies mentioned that it was done either after the test was assessed or without knowing the results. The applicability of the reference test varied greatly due to a lack of consensus on the use of a reference test. Indeed, some studies (13/52) did not use a reference test and others (18/52) used a comparator test that was not the Fried or Rockwood tool. The online resource 2 shows each of the 52 individual QUADAS-2 evaluations.

Tool detection criteria

49 criteria, distributed in nine domains, were identified through the coding grid. The number of criteria per tool varied (from 2 to 24 criteria) with a median of 9 (IQR 6–15) criteria per tool. The nine domains were activity of daily living (ADL), instrumental activity of daily living (IADL), mental state, nutritional state, physical condition, physiopathology, polymedication, socio-demographic data, and personal feeling. The criteria found in the most tools were weight loss (23/36), mobility (22/36), mood (19/36), comorbidities (16/36), polymedication (16/36), balance and falls (15/36), fatigue (15/36), memory (14/36), self-reported health status (14/36), continence (13/36), and social status (13/36). Table 3 show the frequency of each criterion with the tools that use it.

Clinimetric properties

A total of 13 different clinimetric properties were evaluated for the tools, with a mean of 3.6 (±2.2) clinimetric properties per tool. AMPI-AB [28], CFSS-10 [40] and FRAGIRE [41] were the tools with the highest number of clinimetric properties evaluated, with eight evaluations, followed by ZFS [33, 34, 69, 71] (seven evaluations),, FPQ [43] (six evaluations), SC [25, 63] (six evaluations) and sZFS [50, 65] (six evaluations). Table 4 presents the different clinimetric properties evaluated for each tool. The specific values of each of the clinimetric properties are available in the online resource 3.

The 13 different clinimetric properties were classified into five methods of evaluation: reliability, validity, predictive accuracy, outcome predictive ability and feasibility. Reliability regrouped all the clinimetric properties which aimed to identify the degree to which the measurement is free from measurement error. Validity regrouped those which aimed to identify the degree to which an instrument truly measures the construct(s) it purports to measure. Prediction accuracy was for the evaluation of the difference between the expected results and the observed ones, outcome predictive ability for the ability of an instrument to truly predict outcomes that will occur in the future and feasibility for the time that was necessary to use the instrument.

Discussion

This review examined 36 frailty detection tools used by healthcare professionals. The criteria used by the tools to detect frailty were broad, with a total of 49 criteria, of which only three were present in more than half of the tools: weight loss (64%), mobility (61%) and mood (53%). Despite the great diversity of criteria, the most frequent ones are not without reason. For example, it is widely proven that the social situation is closely linked to the health status of the person, with a deterioration of the latter in case of social isolation [74]. It is therefore logical to find the "social status" criterion in 36% of the tools. The observation is the same for weight loss and mobility, both of which address the physical aspect of frailty, the first aspects discussed by Fried's team. Only three tools out of 36 included only physical criteria in their items: the FPQ [43], the FRAIL-NH [27, 29, 48, 51] and the SHARE-FI [23, 62]. This finding supports the trend toward a multidisciplinary approach to frailty detection and the willingness to avoid the use of physical aspect alone, which would tend to fragmentation of care for the older persons [75] and an underestimation of prevalence of frailty [14]. Indeed, this notion seems to be well understood for the development of the tools whose items cover an average of six different domains and the 11 criteria found in the most tools cover eight of the nine domains.

The way tools classify frailty is not homogeneous and the choice of scale is important depending on the purpose of the

Table 3 Distribution of tools for each identified detection criterion

Domain	Criterion	Frequency (%)	Tool(s) that included the criterion
Activity of daily living	ADL	16.7	AMPI-AB, BFIT, BFIT-2, EASY-Care TOS, FI-CGA, GFST
	Continence	36.1	AMPI-AB, EFIP, EFS, FAST, FI-CGA, FI-CLSA, FI-RAI, FRAIL-NH, KFI, KFIm, LASA-FI, SEGAm, VMS
	Dressing	22.2	CFS-TV, EFIP, FI-CLSA, FI-RAI, FRAIL-NH, GFI, LASA-FI, VMS
	Eating	13.9	(fr)AGILE, CFS-TV, FI-RAI, FRAIL-NH, SEGAm
	Mobility	61.1	(fr)AGILE, AMPI-AB, CFS-TV, CFSS-10, EASY-Care TOS, EFIP, FAST, FI-CLSA, FIFE, FI-RAI, FPQ, FRAIL scale, FRAIL-NH, FRESH screening, GFI, GFST, KFIm, LASA-FI, PRISMA-7, SEGAm, SHARE-FI, VMS
	Self-care	25	CFS, CFS-TV, EFIP, FI-CLSA, FIFE, FI-RAI, LASA-FI, LoFProS, VMS
	Toileting	13.9	CFS-TV, EFIP, FI-RAI, GFI, VMS
Physical condition	Balance and fall	41.7	ABCDEF, AMPI-AB, EASY-Care TOS, EFIP, FI-CGA, FI-CLSA, FI-RAI, FRAGIRE, FRESH screening, LoFProS, SC, SEGAm, VMS, ZFS, ZFSs
	Fatigue	41.7	(fr)AGILE, CFS-TV, CFSS-10, EFIP, FAST, FIFE, FI-RAI, FPQ, FRAGIRE, FRAIL scale, FRAIL-NH, FRESH screening, GFST, KFS, SHARE-FI
	Gait speed	27.8	ABCDEF, EFS, FAST, FI-CGA, FI-RAI, FRAGIRE, GFST, KFI, KFS, LoFProS
	Grip strength	8.3	(fr)AGILE, FRAGIRE, SHARE-FI
	Physical activity	33.3	CFS, CFSS-10, EFIP, FI-RAI, FPQ, FRAGIRE, KFS, LASA-FI, LoFProS, PRISMA-7, SC, SHARE-FI
Socio-demographic data	Age	11.1	AMPI-AB, Frailty Predictor, PRISMA-7, SEGAm
	Financial difficulties	8.3	(fr)AGILE, FRAGIRE, SC
	Home care	30.6	(fr)AGILE, AMPI-AB, CFS, EASY-Care TOS, EFIP, FI-CGA, LoFProS, PRISMA-7, SEGAm, VMS, ZFS
	Internet	2.8	FRAGIRE
	Sex	8.3	Frailty Predictor, PRISMA-7, SHARE-FI
	Sexual activity	2.8	FRAGIRE
	Social status	36.1	BFIT-2, EASY-Care TOS, EFIP, EFS, FIFE, FRAGIRE, GFST, KFS, LoFProS, PRISMA-7, SC, ZFS, ZFSs
Mental state	Attention (concentration)	13.9	ABCDEF, CFSS-10, FI-CLSA, FI-RAI, LASA-FI
	Language	5.6	FI-CLSA, FI-RAI
	Memory	38.9	(fr)AGILE, ABCDEF, AMPI-AB, EFIP, FAST, FI-CLSA, FI-RAI, GFI, GFST, LASA-FI, SC, VMS, ZFS, ZFSs
	Mood	52.8	(fr)AGILE, ABCDEF, AMPI-AB, CFSS-10, EASY-Care TOS, EFIP, EFS, FAST, FI-CGA, FI-CLSA, FI-RAI, FRAGIRE, GFI, KFI, KFIm, LASA-FI, LoFProS, SC, SEGAm
	Orientation	22.2	(fr)AGILE, ABCDEF, CFSS-10, EFIP, EFS, FI-RAI, LASA-FI, VMS
	Psychiatric condition	19.4	ABCDEF, BFIT, BFIT-2, EASY-Care TOS, FI-CGA, LoFProS, SEGAm
	Sleep	2.8	FI-RAI

Table 3 (continued)

Domain	Criterion	Frequency (%)	Tool(s) that included the criterion
Instrumental activity of daily living	Cooking	8.3	CFS-TV, EFS, FI-CLSA
	Housekeeping	11.1	CFS-TV, EFIP, EFS, FI-CLSA
	Laundry	5.6	CFS-TV, EFS
	IADL	8.3	AMPI-AB, CFS, SEGAm
	Managing money	11.1	ABCDEF, CFS-TV, EFS, FI-CLSA
	Shopping	16.7	CFS-TV, EFIP, EFS, FI-CLSA, FRESH screening, GFI
	Taking medicine	13.9	ABCDEF, CFS-TV, EFIP, EFS, FI-CLSA
	Using telephone	11.1	ABCDEF, CFS-TV, EFS, FI-CLSA
	Using transport	16.7	ABCDEF, CFS-TV, EFIP, EFS, FI-CLSA, LASA-FI
Physiopathology	Comorbidities	44.4	ABCDEF, AMPI-AB, CFS, CFS-TV, CFSS-10, EASY-Care TOS, EFIP, FAST, FI-CGA, FI-CLSA, FI-RAI, FRAIL scale, frailty predictor, LASA-FI, SEGAm, VMS
	Hearing and vision difficulties	30.6	AMPI-AB, BFIT-2, CFSS-10, EASY-Care TOS, EFIP, FI-CGA, FI-CLSA, FI-RAI, GFI, KFI, KFIm
	Hospitalisation	30.6	ABCDEF, AMPI-AB, EFIP, EFS, FIFE, FRAGIRE, frailty predictor, FRESH screening, KFI, KFIm, LoFProS
	Medical follow-up	5.6	FRAGIRE, SC
	Pain	8.3	EFIP, FAST, FI-RAI
Poly-medication	Polymedication	44.4	ABCDEF, AMPI-AB, EASY-Care TOS, EFIP, EFS, FAST, FI-RAI, frailty predictor, GFI, KFI, KFIm, LoFProS, SC, SEGAm, ZFS, ZFSs
Nutritional state	Appetite loss	16.7	CFSS-10, FAST, FIFE, FI-RAI, SEGAm, SHARE-FI
	BMI	8.3	ABCDEF, FI-RAI, VMS
	Oral disability	8.3	AMPI-AB, FIFE, FI-RAI
	Taste	2.8	FRAGIRE
	Weight loss	63.9	(fr)AGILE, ABCDEF, AMPI-AB, BFIT-2, EFS, FAST, FI-CGA, FIFE, FI-RAI, FPQ, FRAIL scale, FRAIL-NH, GFI, GFST, KFI, KFIm, KFS, LoFProS, SC, SEGAm, VMS, ZFS, ZFSs
Personal feeling	Patient involvement	2.8	GFST
	Self-reported health status	38.9	AMPI-AB, CFS-TV, EFIP, EFS, FAST, FI-CLSA, FIFE, FRAGIRE, GFI, KFI, KFIm, KFS, LASA-FI, SEGAm
	Subjective assessment of the healthcare professional	8.3	EASY-Care TOS, FRAGIRE, GFST

tool. We noticed three different population settings (people living in the community, hospitals, and nursing homes) with a detection objective that may be different from one setting to another. As frailty is a reversible and preventable syndrome, earlier detection for people living in the community (which was represented in 35 of the 52 included studies) allows a better management of frailty [76]. Use of tools that detect pre-frail individuals such as FAST [37] or ZFS [33, 34, 69, 71] are of great interest in primary care for the reasons mentioned above.

A total of five different methods were used to evaluate the different clinimetric properties but none of the tools was evaluated through these five methods. Indeed, there were only five out of 36 tools evaluated by four methods, which highlights a lack of consistency in the recommendations for the evaluation of frailty detection tools. Moreover, none of the methods is used by all tools, with a maximum of 53% of use for validity, and even falling to 22% of use for feasibility. Without the evaluation of these different clinimetric parameters, it is difficult to guarantee the quality of the results obtained by the tools.

As outlined above, feasibility is very poorly assessed for the tools, with only eight out of 36 that conducted a feasibility test. Yet this information is crucial for the healthcare professional because each professional does not have the same amount of time to devote to frailty detection. A general practitioner, for example, will have less time than a geriatrician. But, looking at the few tools that did evaluate this

Table 4 Comparison of the clinimetric properties evaluated by the different tools

	Reliability			Validity			Predictive accuracy					Outcome predictive ability	Feasibility
	Test-retest reliability	Inter-rater reliability	Internal consistency	Internal validity	Construct validity	Criterion validity	Discriminant capacity	Se & Sp	Diagnostic accuracy	PPV & NPV	Likelihood ratio		
(fr)AGILE		✓	✓									✓	✓
ABCDEF							✓	✓		✓			✓
AMPI-AB	✓	✓	✓				✓	✓	✓			✓	✓
B-FIT							✓	✓	✓				
B-FIT2					✓		✓	✓	✓				
CFS		✓			✓							✓	
CFS TV		✓			✓	✓							
CFSS-10	✓		✓		✓		✓	✓	✓	✓		✓	
EASY-Care TOS		✓			✓							✓	✓
EFIP	✓	✓			✓								
EFS		✓	✓		✓								✓
FAST	✓		✓		✓		✓	✓					
FI-CGA		✓			✓							✓	
FI-CLSA													
FIFE			✓										
FI-RAI			✓									✓	
FPQ					✓	✓	✓	✓	✓	✓			
FRAGIRE	✓		✓	✓	✓		✓	✓	✓	✓			
FRAIL scale												✓	
FRAIL-NH					✓		✓	✓				✓	
Frailty predictor							✓						
FRESH screening							✓	✓		✓			
GFI			✓	✓	✓								
GFST		✓						✓		✓	✓		
KFI					✓	✓	✓	✓	✓				
mKFI					✓	✓	✓	✓	✓				
KFS							✓	✓		✓		✓	
LASA-FI												✓	
LoFRoS													
PRISMA-7												✓	
SC					✓	✓	✓	✓	✓	✓			
SEGAm	✓		✓	✓								✓	✓
SHARE-FI												✓	
VMS												✓	
ZFS			✓		✓		✓	✓	✓	✓			✓
sZFS					✓		✓	✓	✓	✓			✓

Se sensibility, *Sp* specificity, *PPV* positive predictive value, *NPV* negative predictive value

clinimetric property, we can see quite logically that the fewer criteria the tool has, the faster it is to use. However, more evaluations need to be conducted to compare them more widely and confirm this finding. Moreover, not all criteria are equal in terms of completion time. For example, assessing walking speed usually requires a test, such as the Time Up and Go (TUGT) or the 4-m walking speed, while assessing weight loss is usually done through a question. Asking a question will be less time consuming than performing a test. A tool composed only of questions is therefore short and easy to use but the veracity of the answers cannot be guaranteed, whereas a tool composed only of tests and clinical data requires more time and resources, but the information obtained is more reliable. The former should therefore only be used for screening while the latter should be used for a full assessment. This conclusion was already noted when comparing the use of the FP and FI [77]. Based on the observation that most tools are derived from FP and FI, it might be an interesting approach to consider FP-derived tools as screening tools (used in primary care) and FI-derived tools as assessment tools (used in hospitals or nursing homes). This approach does, however, need further investigation.

It is well documented that the frail syndrome increases the risk of falls, hospitalisation, long-term care and death [78–80]. Assessing the ability to predict one or more of these outcomes is therefore important, especially in the absence of a gold standard to compare tools [10]. With the current observation that the frail phenotype and the FI are the two references for the detection of frailty [12], a validation against one of these two tools therefore seems to be preferred. Of the 36 tools, only AMPI-AB [28], CFS [24, 31], CFSS-10 [40], EASY-Care TOS [32, 56], FI-CGA [55], (fr) AGILE [64], FRAIL-NH [27, 29, 48, 51] and KFS [39] both assessed this capacity to predict one or more outcomes and were compared to one of the two references.

There are currently only four reviews that present frailty detection tools as extensively as ours. The first two, from 2010 [81] and 2013 [82], identified only 20 and 27 tools respectively, while the second two, from 2019 [11] and 2021 [83], identified 51 and 42 tools respectively. This difference is explained by the ever-increasing number of new tools over the years, making the older systematic reviews already obsolete. In addition, the criteria for including tools in the systematic review often differ, which also explains the difference between the 51 tools identified in the 2019 review, the 42 in 2021 review and our 36 tools. For example, we only selected tools used by health professionals and excluded self-tests, unlike the other two studies. However, regardless the inclusion criteria, the conclusions in terms of detection criteria remain the same. Our review goes one step further by identifying all the criteria used by the tools and the recurrence of these criteria in the tools. Due to the lack of consensus on the definition of frailty, the approach will differ depending on the definition chosen by the healthcare professional [84]. Regarding the analysis of the evaluation of clinimetric parameters, our review does not always yield the same conclusions as the others. Indeed, the 2019 review included studies on specific populations, such as an article that focuses just on women [85]. This inclusion of articles brings a greater number of evaluated clinimetric properties for the tools, but the results cannot always be extrapolated to the general population, which we wanted to avoid in our review. Moreover, the 2021 review analysed only a few clinimetric properties (reliability, validity, and the cut-off value) without offering a clear comparison.

Despite the Fried and Rockwood models developed in the early 2000s, there is currently no clear consensus on defining and detecting frailty. One of the consequences of this is the large and growing number of frailty detection tools. Therefore, it seems more and more difficult to agree on a definition and a specific detection tool. However, the WHO may have found a solution in 2015, by introducing the concept of intrinsic capacity. Focused on a concept of healthy aging, this new approach may indeed have been introduced to reverse the trend and see aging from a new perspective. This approach is even considered by some as an evolution of the concept of frailty [86]. Moreover, this new concept is accompanied by its programme, Integrated Care for Older People (ICOPE), directly developed by the WHO, providing a solution to the problem of defining frailty as well as its detection. Indeed, the first step of the programme (of which there are five) is a questionnaire for detecting declines in intrinsic capacities, exploring mobility, mood, cognition, vision, hearing and nutrition. This screening is currently the only integrated care tool for older people recognised by the WHO [87].

Our systematic review has several strengths. First, we tried to include the most representative population possible, with no age or pathology limitations. Second, our data were extracted in a rigorous manner using a coding system, which makes data collection more consistent and more systematic. The main limitation is the non-inclusion of translation validation studies of the tools. We also limited our research to the tools published in English or French, which may have led to the exclusions of original tools published in local journals. The final limitation, inherent in any systematic review, is the risk of missing studies, despite the rigour of the review and the search of several databases and grey literature [88].

In conclusion, this systematic review has identified and listed the detection criteria used by 36 frailty screening tools, offering healthcare professionals all the information necessary to choose the most appropriate tool in their practice. Because of the great heterogeneity that exists in the tools, healthcare professionals should choose a tool that includes criteria which best fit their practice and with a number of items which suits the time they have. A multidisciplinary

approach should be favoured in all cases. This review also provides an overview of the evaluation methods of the different tools and highlights a lack of homogeneity in these evaluations. Indeed, there is a lack of clear recommendations for evaluating the tools, which could lead to inconsistent detection of frailty. Particular attention should therefore be paid in the coming years to the drafting of clear recommendations for the evaluation of tools.

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Declarations

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