

The relationship between frailty and social vulnerability: a systematic review

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Both frailty (reduced physiological reserve) and social vulnerability (scarcity of adequate social connections, support, or interaction) become more common as people age and are associated with adverse consequences. Analyses of the relationships between these constructs can be limited by the wide range of measures used to assess them. In this systematic review, we synthesised 130 observational studies assessing the association between frailty and social vulnerability, the bidirectional longitudinal relationships between constructs, and their joint associations with adverse health outcomes. Frailty, across assessment type, was associated with increased loneliness and social isolation, perceived inadequacy of social support, and reduced social participation. Each of these social vulnerability components was also associated with more rapid progression of frailty and lower odds of improvement compared with the absence of that social vulnerability component (eg, more rapid frailty progression in people with social isolation *vs* those who were not socially isolated). Combinations of frailty and social vulnerability were associated with increased mortality, decline in physical function, and cognitive impairment. Clinical and public health measures targeting frailty or social vulnerability should, therefore, account for both frailty and social vulnerability.

Introduction

Frailty, an age-related state of reduced physiological reserve, is a global clinical and public health challenge.¹ By 2050, over 1.5 billion people worldwide are expected to be aged over 65 years;² this rapid growth in the older population is accompanied by an increase in the number of older adults living with frailty.³ Frailty is associated with increased risks of mortality, hospital admission, functional decline, and loss of independence.⁴ Social vulnerability—which can be defined across several different domains—describes deficiency in the quality or quantity of social connections, or the degree of support, available to individuals.⁵ Similar to frailty, social vulnerability is growing in prevalence, and has been linked to a range of adverse health outcomes.^{6,7}

Despite being distinct constructs, frailty and social vulnerability often, and increasingly, coexist.^{8–10} However, given the range of models that are used to operationalise both frailty and social vulnerability (which differ in both their theoretical underpinnings and in the associated measures and scales), the relationship between the constructs remains difficult to understand. Aside from the Fried frailty phenotype and frailty index (the most frequently used measures),^{11,12} a range of other frailty measures have emerged, some of which explicitly include psychosocial dimensions.^{13,14} Social vulnerability comprises a range of concepts, including loneliness (a subjective mismatch between an individual's desire for social connection and their perceived social connection) and social isolation (an objective deficiency in an individual's frequency or range of social contacts).¹⁵ Other researchers have combined social deficits into summary measures (such as the social vulnerability index, which reflects the cumulative total of social deficits across multiple domains, using a similar approach to the frailty index),¹⁶ or proposed measures of so-called social frailty, which typically include several domains

(including, but not limited to, loneliness, social isolation, and social support) across a range of combinations.¹⁷

The range of concepts used to capture social vulnerability (and the range of measures used to assess frailty) poses a challenge to understanding the relationship between frailty and social vulnerability. Previous systematic reviews have examined the association between frailty and single concepts of social vulnerability such as loneliness or social isolation.^{18,19} We sought to systematically review the relationship between frailty and social vulnerability, taking a broad approach that encompasses the range of measures used for either construct. More specifically, our systematic review aims to: first, describe the prevalence of frailty in people experiencing social vulnerability and the prevalence of social vulnerability in people with frailty (cross-sectional associations); second, assess the bidirectional, longitudinal relationship between frailty and social vulnerability; and third, explore whether the combination of frailty and social vulnerability is associated with an increased risk of adverse health outcomes.

Methods

Search strategy and selection criteria

This systematic review was conducted according to a registered protocol (PROSPERO, CRD42023425870) and reported according to PRISMA guidelines.

We searched six electronic databases (MEDLINE, Embase, Web of Science Core Collection, Scopus, PsycINFO, and Cumulative Index to Nursing and Allied Health Literature) using a combination of medical subject headings and keyword searches for articles published between Jan 1, 2001 (the year when the Fried frailty phenotype and frailty index were first proposed), and April 28, 2023. The full search strategy, shown in the appendix (p 2), was structured as “frailty” terms and “social vulnerability” terms, and there was no language

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See Online for appendix

restriction on the search results. Titles and abstracts of all studies identified were screened independently by two reviewers to identify potentially eligible studies, full texts of which were obtained and screened against our eligibility criteria. Disagreement between reviewers was resolved by consensus, involving a third reviewer if

	Description and criteria	Number of included studies using measure
Frailty	A state of reduced physiological reserve resulting in increased vulnerability to decompensation in response to stressors ⁴	..
Fried frailty phenotype	Based on five criteria: unintentional weight loss, low grip strength, slow gait speed, self-reported exhaustion, low physical activity; 0=robust, 1-2=pre-frail, ≥3=frail	58
Frailty index	A frailty index is constructed by calculating the sum of age-related and health-related deficits within an individual; ≥30 deficits usually included, which can be long-term conditions, symptoms, signs, and functional limitations; deficits should increase in prevalence with age, be related to poor health, and be neither too common nor too rare to add discrimination to the index; values from 0 to 1, with higher values indicating a greater degree of frailty	33
FRAIL scale	Frailty screening tool conceptually based on the frailty phenotype; criteria include fatigue, resistance (weakness), ambulation, illness, and loss of weight; 0=robust, 1-2=pre-frail, ≥3=frail	18
Tilburg Frailty Indicator	15 questions across three domains (physical, psychological, and social); responses combined into unweighted sum	16
Clinical frailty scale	Clinical tool conceptually linked to the frailty index; frailty defined on the basis of clinical assessment of functional limitation and graded from very fit to terminally ill; number of levels ranges from 7 to 9 depending on the iteration of the scale	5
Groningen frailty indicator	15 items across four domains (physical, cognitive, social, and psychological)	2
Social support	Degree of support available to an individual: often subclassified (emotional support, instrumental support, material or financial support, and informational support) ²⁰	..
Social support rating scale	Four-item construct assessing instrumental support, informational support, emotional support, and appraisal support	6
Multidimensional scale of perceived social support	12-item scale assessing adequacy of support from family, friends, and significant others	2
Medical Outcomes Study—Social Support Scale	19-item scale assessing emotional or informational support, tangible support, affectionate support, and positive social interaction	2
Other scales	Other studies used alternative scales (although no other scale was used in >1 included study) or used questions relating to emotional, instrumental, or material social support	26
Loneliness	Subjective experience of feeling alone ⁶	..
UCLA Loneliness Scale	20-item questionnaire assessing aspects of loneliness; studies used either the full version (one study) or an abbreviated eight-item (two studies) or three-item (seven studies) version	10
De Jong Gierveld Loneliness Scale	11-item scale assessing emotional loneliness and social loneliness	9
Single-question assessments of loneliness	Vary depending on study or survey, but can include direct assessment of loneliness (How often do you feel lonely?) or indirect (Do you have someone you can confide in?)	12
Social isolation	Deficiency in the number or quality, or both, of social contacts ²¹	..
Lubben Social Network Scale	Questionnaire assessing social isolation, quantifying interaction and support from family and friends; 12-item and six-item versions available	12
Assessments of network size or quality	Other studies used non-validated questions to assess the size or quality, or both, of a person's social network, or the frequency of social contact; questions usually adapted to available data in secondary analysis	24
Social vulnerability index	Defines social vulnerability as the cumulative sum of social deficits ¹⁶	..
Social vulnerability index	Calculated using a similar approach to the frailty index as the non-weighted sum of social deficits; items include living situation, social support, leisure activities, socioeconomic variables, and social engagement	12
Social frailty	Variably defined concept, relating to a range of social domains, deficiencies in which confer vulnerability to adverse outcomes ²⁷	..
Social subscale from multi-dimensional frailty tools	Tilburg Frailty Indicator—social subscale: includes whether participants are living alone, miss having people around them, have sufficient social support	7
Multi-item scales	Measures are usually study-specific and incorporate or merge aspects of other constructs (such as loneliness, social isolation, social support, social participation), along with other domains such as financial situation or living alone; selection of items tended to be based on the theoretical framing of social frailty by Bunt and colleagues, 2017	15
Social participation	Degree of participation in community activities ²²	..
No specific measures cited	Studies included assessments of voluntary activities, participation in community groups, and participation in exercise-based activities; combinations and quantification of these activities varied between studies	11

Table: Definitions and measures of frailty and social vulnerability

needed. Database searches were supplemented by hand-searching of reference lists of included studies and relevant review articles as well as forward citation searches of included studies using Web of Science Core Collection.

In this systematic review, we focused on observational studies assessing both frailty and social vulnerability. To be eligible, studies had to include adults (18 years and older), and measure both frailty and social vulnerability (regardless of the frailty measure provided—either a validated measure or the criteria were clearly described within the study). Eligible measures of social vulnerability included degree of social support, social isolation, loneliness, social participation, and composite measures such as the social vulnerability index or social frailty, where the criteria used to define this composite measure were described within the study (table). Eligible studies compared social vulnerability in participants with different levels of frailty, or compared frailty in participants with different levels of social vulnerability. Relevant outcomes included associations between frailty and social vulnerability, longitudinal changes in frailty or social vulnerability status, or clinical outcomes (such as mortality, hospital admission, nursing home admission, falls, functional impairment or disability, quality of life, cognitive decline, and depression) where studies assessed the interplay between both frailty and social vulnerability in association with these outcomes. Cross-sectional or longitudinal (cohort) studies were eligible for inclusion. Eligible studies focused on community settings (defined as any setting outside of a hospital, including nursing homes). Grey literature and conference abstracts were excluded.

Data extraction and analysis

Data from each of the eligible studies were extracted using a piloted template. Data were extracted by PH, and checked by HW, MP, SK, and CJ (as second, independent reviewers). We assessed the risk of bias for each of the included studies using Joanna Briggs Institute critical appraisal checklists appropriate to the study type (cross-sectional or cohort study).²³ Quality assessment was completed by PH and checked by HW, MP, SK, and CJ (as second, independent reviewers). We performed a narrative synthesis of all study findings. Assessments of the cross-sectional and longitudinal associations between frailty and social vulnerability were presented descriptively and summarised using harvest plots (a tool to allow presentation of diverse outcomes and study designs).

Results

Study selection and characteristics

We identified 130 studies that met our inclusion criteria (figure 1),^{16,24–152} which included data from 100 different cohorts or samples. Cohorts analysed in multiple studies included the Survey for Health, Ageing, and

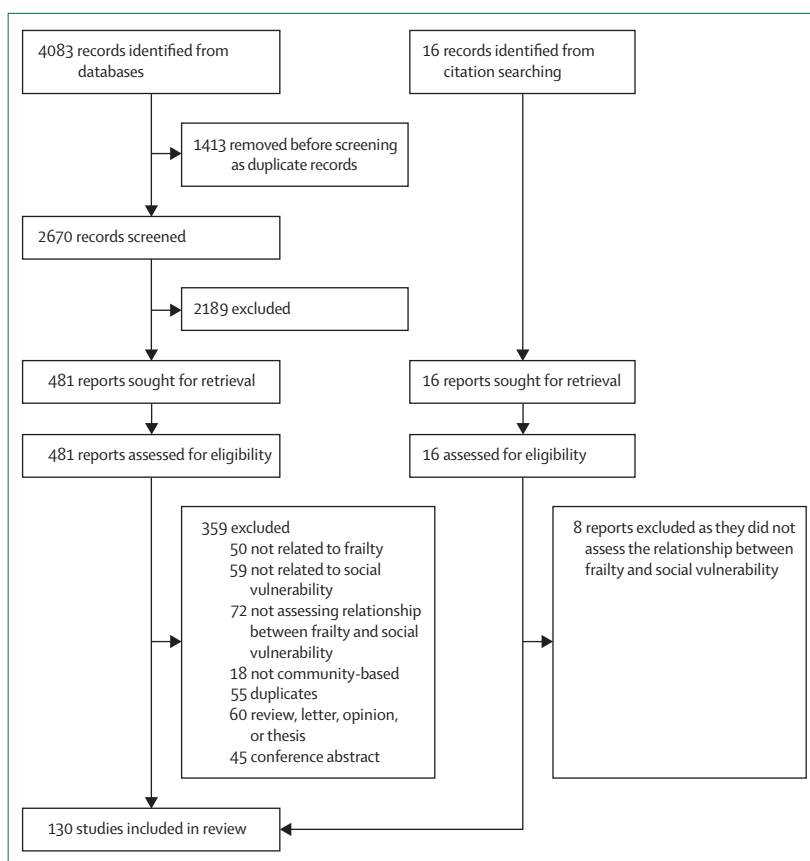


Figure 1: Flowchart of study selection

Retirement in Europe (SHARE, six studies), English Longitudinal Study of Ageing (ELSA; five studies), and the China Health and Retirement Longitudinal Study (CHARLS, five studies).

We identified studies from 27 countries, and nine studies included samples from multiple countries (six used SHARE; appendix p 5). Sample size ranged from 70 to 27 468 participants, and mean age ranged from 52 years to 90 years. All studies focused on either older adults or middle-aged and older adults, defined in different ways; however the lower age limit for inclusion ranged from 40 years to 85 years (median 65 years, IQR 60–65 years). The median percentage of female participants was 57% (IQR 50–61). Of the selected studies, 90 assessed the cross-sectional relationship between frailty and social vulnerability, 36 assessed longitudinal changes in these constructs, and 23 assessed the relationship between these constructs and clinical outcomes. Measures of frailty and social vulnerability are summarised in the table.

Quality assessment

Quality assessment is shown in the appendix (pp 3–4). Studies were generally high quality in their description of participants and measures used; however, adjustment

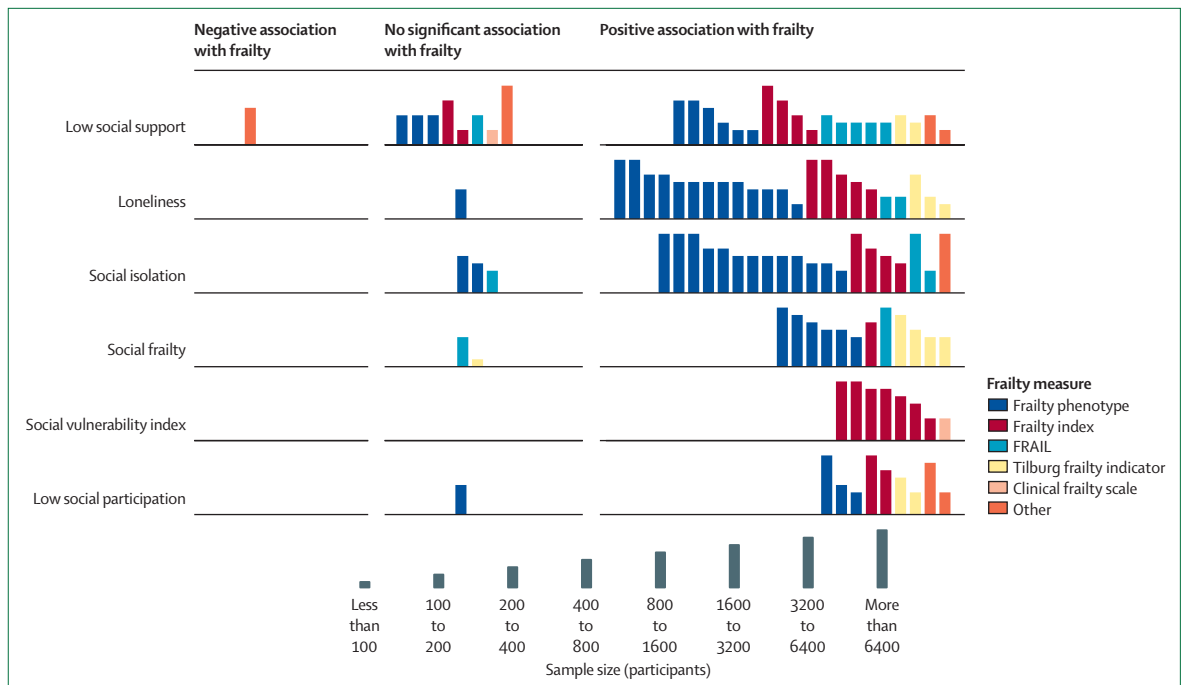


Figure 2: Harvest plot of cross-sectional associations between frailty and social vulnerability

The findings of studies assessing the cross-sectional association between frailty and social vulnerability are summarised. Each bar represents a study. The height of the bar indicates the sample size. The position of the bar on the matrix shows the association between frailty and social vulnerability—positive associations indicate higher frailty prevalence with greater social vulnerability. Where two or more studies used the same dataset, the same frailty measure, and the same social vulnerability measure, these are represented by a single bar (using the study with the largest sample size). Frailty measures grouped as other included comprehensive geriatric assessment, frailty staging system, Groningen frailty indicator, Kihon checklist, and the study of osteoporotic fractures frailty measure.

for confounding was more variable, with many cross-sectional studies only reporting unadjusted associations.

Cross-sectional associations

Findings from the cross-sectional associations are summarised in figure 2. Frailty was consistently associated with increased levels of loneliness (23 of 24 studies), increased social vulnerability index values (eight of eight studies), and reduced social participation (nine of ten studies). Most studies also found that frailty was associated with greater degrees of social isolation (20 of 23 studies), social support (19 of 28 studies), and social frailty (12 of 14 studies), although some studies did not find significant associations.

Social isolation was assessed through survey questions either using the Lubben social network scale (eight studies), or by network size, frequency of social contact, or both, through survey questions (15 studies). 20 of 23 studies found that frailty was associated with increased social isolation. Two studies distinguished between isolation from family and isolation from wider networks (eg, friends or neighbours), finding that frailty was associated with isolation from wider networks but not from family.^{39,40} A third study found no significant association between frailty and isolation, but this study had a small sample size (202 participants in total,

11 with frailty) and might therefore have been underpowered.⁹³ Most analyses were descriptive (without adjustment for possible confounders), with the exception of two studies that adjusted for age, sex, socioeconomic position, and marital status. Both these studies found increased odds of frailty associated with social isolation overall (odds ratio [OR] 2.5, 95% CI 1.4–4.4),¹³² or social isolation from wider social networks (3.06, 1.66–5.64) but not from immediate family (1.34, 0.75–2.40).³⁹ Taken together, these studies show consistent evidence for an association between social isolation and frailty, and highlight the potential for this relationship to vary depending on the type of social isolation.

Loneliness was assessed using either a version of the UCLA Loneliness Scale, the De Jong Gierveld Loneliness Scale, or by non-validated questions (including direct assessments of loneliness [eg, how often do you feel lonely?], or indirect assessments [eg, do you have someone in whom you can confide?]). All but one study found significantly higher levels of loneliness in people living with frailty (23 of 24 studies showing significant associations). These studies were largely descriptive; however, five studies assessed the association between loneliness and frailty after controlling for age, sex, socioeconomic position, and marital status.^{33,90,108,116,139} Each of these studies found significant associations between loneliness and frailty after adjustment for

confounders (OR ranging from 1.95 [1.12–3.41] to 4.16 [1.57–11.40]). However, these studies assessed loneliness using a single question only, and no studies were identified that used both a validated questionnaire and that adjusted for potential confounders. Despite this limitation, the available evidence supports an association between the experience of loneliness and frailty.

The assessment of social support in the included studies was more heterogeneous. The tools used in the studies assessed social support across multiple domains (eg, emotional support, instrumental support, informational support, and financial support), but varied in terms of which of these domains were included in analyses and how they were assessed. Studies also either assessed degree of social support received or perceived adequacy of social support. As such, variation in measurement of social support might influence the assessment of associations between frailty and social support. Although most studies found that frailty was associated with low social support, eight of 28 studies found no significant association and one of 28 studies found a negative association between frailty and low social support (figure 2). All studies that showed no association between frailty and social support assessed the availability of support (using various scales) rather than the perceived adequacy of support.^{30,35,37,38,91,95,114,117} One of these studies focused on adults experiencing homelessness, which reflects a specific context that might not be generalisable to older adults.¹¹⁴ Overall, although findings were mixed, frailty was frequently associated with lower availability of social support, and consistently associated with perceived low availability of sufficient social support.

The social vulnerability index is an unweighted cumulative count of social deficits. Similar to the frailty index, the included deficits can vary between studies and can be adapted to the available data. Typically, elements of social isolation, loneliness, and social support are included, sometimes with additional concepts such as financial insecurity or literacy. Seven studies assessed the association between the social vulnerability index and frailty used the frailty index,^{16,24,29,30,31,43} and one additionally used the clinical frailty scale.⁶² All seven studies showed a significant association between frailty and social vulnerability (either showing a significant correlation or a significant increase in frailty index values per unit increase in social vulnerability using linear regression models). One study, using two separate datasets, showed that the correlation between the frailty index and the social vulnerability index was higher for women (correlation coefficients 0.24 and 0.47) than men (0.13 and 0.37).¹⁶

Social frailty was variably defined in the included studies, although these definitions fell into two broad categories. Five of 14 studies used the social dimension of multidimensional measures of frailty (such as the social subscale of the Tilburg Frailty Indicator) to define

social frailty.^{58,61,68,75,133} These studies assessed the association between social frailty and either the physical frailty subscale of the same measure used to assess social frailty, or alternative measures of frailty. Nine of 14 studies used their own measures of social frailty; these measures varied in their components but each included multiple elements drawing on aspects of social isolation, loneliness, low availability of social support, and other features, such as financial insecurity or living alone. These elements were then combined to form a composite measure of social frailty. Many studies justified the selected components on the basis of Bunt and colleagues' conceptual review, in which social frailty was defined as "being at risk of losing, or having lost, resources that are important for fulfilling one or more basic social needs".¹⁷

In general, a greater degree of social frailty was associated with a greater degree of physical frailty (11 of 14 studies). One small study⁶⁸ that compared subscales of the Tilburg Frailty Indicator found that the correlation between physical and social subscales included the null; however, this finding was probably due to low statistical power, as four larger studies using the same measure showed a significant positive association between physical and social subscales.^{58,61,75,133} Another conflicting study used a dichotomous measure of social frailty and three physical categories (robust, pre-frail, and frail) of the FRAIL (fatigue, resistance, ambulation, illness, and loss of weight) scale and found that the association between social frailty and physical frailty was not significant in a descriptive analysis of prevalence (348 participants in total, 18 with frailty);²⁵ however, a larger study using similar measures (6603 participants, 1091 with frailty) found a significantly higher prevalence of social frailty in participants with physical frailty (32.2%) compared with patients who were not physically frail (12.3%).¹³⁵ Therefore, despite some conflicting results found in smaller studies, physical frailty was associated with social frailty across a range of multicomponent measures.

Seven^{50,60,81,83,111,127,147} of eight⁴⁹ studies that assessed the association between low social participation and frailty found that people living with frailty reported lower participation in activities such as community organisations, volunteering, and clubs. In studies that subcategorised these activities, frailty was particularly associated with low participation in sport or exercise activities.

Longitudinal relationships between frailty and social vulnerability

Findings from the 36 studies that assessed longitudinal association between frailty (32 studies) or social vulnerability status (nine studies) are shown in figure 3.

Findings assessing the rate of deficit accumulation (measured by change in the frailty index) were inconsistent. Comparison of the studies that had conflicting results suggested that this inconsistency probably reflects

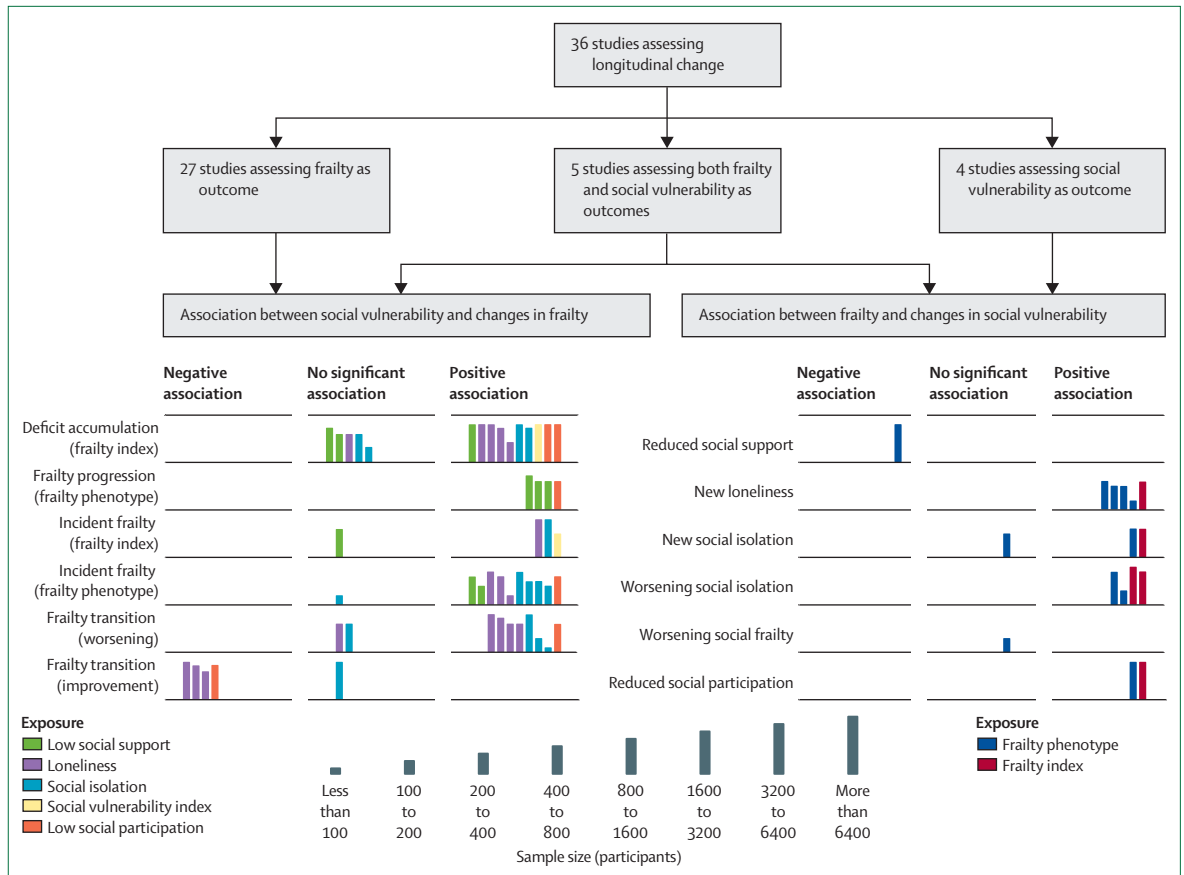


Figure 3: Harvest plot of longitudinal relationships between frailty and social vulnerability
 The findings of studies assessing longitudinal association between baseline social vulnerability and frailty status (left panel) and between baseline frailty and social vulnerability status (right panel) are summarised.^{24,27,33,41,42,44,46,49,53-55,57,64,72,74,77,79,96,97,103,104,107,109,110,118-120,123,127,131,136,137,142,145,151,152} Each bar represents a study. The height of the bar indicates the sample size. The position of the bar on the matrix shows the direction of association.

methodological differences, including sample selection, length of follow-up, and the way in which social isolation was defined. Notably, three studies with apparently conflicting results used the same dataset (ELSA) and assessed associations between baseline social isolation and change in the frailty index.^{44,54,97} Gale and colleagues⁵⁴ used waves 2–5 (approximately 8 years of follow-up) and included participants aged 60 years and older with complete baseline and follow-up data (n=2817). They found that high baseline social isolation was not associated with a significant change in the frailty index (coefficient -0.008, -0.10 to 0.086). Davies and colleagues⁴⁴ took a similar approach to measuring social isolation but used a longer follow-up period (waves 2–8, approximately 12 years follow-up), a larger sample (n=9171, with participants added at subsequent waves), and analysed participants aged 50 years and older. They found a significant association between baseline social isolation and deficit accumulation, measured using the frailty index (coefficient 0.012, 0.009 to 0.013). Similar analyses for loneliness showed that the association between loneliness and change in

frailty was not significant in the study by Gale and colleagues (β coefficient -0.007, CI -0.111 to 0.096); however, Davies and colleagues' analysis showed that medium and high levels of baseline loneliness were associated with an increased risk of developing frailty (β coefficient 0.035, CI 0.032 to 0.036). The third study using ELSA also assessed social isolation but quantified it differently; using principal component analysis, Maltby and colleagues⁹⁷ identified three dimensions to the social isolation construct: isolation from nuclear family, isolation from wider family, and isolation from wider networks. They found that a unidimensional model of social isolation (as used in previous studies) was not associated with increasing frailty index values, but when using a multidimensional approach isolation from a wider social network was a significant predictor of worsening frailty over 6 years of follow-up.

A further two studies^{57,123} showed that loneliness was associated with more rapid increases in frailty index deficits over time. Low social support was associated with deficit accumulation in one study (using ELSA) but was not in another. Higher social vulnerability index

(one study) and lower social participation (one study) were associated with deficit accumulation.

Four studies (three using the Fried frailty phenotype, one using the FRAIL scale)^{46,53,79,107} assessed frailty progression by using latent growth curve models to classify participants into different trajectories. Each of these studies demonstrated that participants with low social support (three studies) or low social participation (one study) were more likely to show trajectories of rapidly increasing frailty (compared with stable, low-frailty states).

Among participants who were either not frail at baseline (frailty phenotype) or had frailty index values below a given threshold, most studies showed that loneliness (four of four studies), social isolation (five of six studies), low social support (two of three studies), higher social vulnerability index values (one of one study), and lower social participation (one of one study) were associated with the development of frailty over follow-up periods varying from 2 years to 12 years.

Finally, six studies explored the relationship between social vulnerability and transitions between frailty states.^{41,54,77,118,120,131} Loneliness was associated with increased odds of transitioning from a robust or pre-frail state to a frail state (four of five studies) and with reduced odds of improving from a frail state to a pre-frail state or robust state (three of three studies). Lower social participation was associated with transition towards frailty in one study and with reduced odds of improvement in another. Findings for social isolation were mixed, with three studies finding that people who were not frail or pre-frail but were socially isolated were at greater risk of transitioning to a frail state, although one study found no significant association with worsening frailty and another study found no significant association between social isolation and the odds of improvement in frailty status.

Nine studies assessed relationships between frailty and changes in social vulnerability.^{49,54,72,97,103,109,119,150,152} Four of these studies assessed bidirectional relationships: the two aforementioned studies from Gale and colleagues⁵⁴ and Maltby and colleagues⁹⁷ using the ELSA, and two additional studies using data from CHARLS¹²⁰ and the Chinese Longitudinal Healthy Longevity Survey,¹⁵² respectively. Collectively, these four studies found that baseline frailty was associated with worsening loneliness, social isolation (particularly from wider social networks), or both. The remaining five studies showed that frailty was associated with increases in social support provision over time but reduction in social participation;¹⁰⁹ that frailty was associated with declines in social participation;⁴⁹ that baseline frailty was associated with increases in loneliness but not social isolation (measured by size of social network);⁷² and that baseline frailty was not associated with changes in social frailty when using a broad definition of social frailty, but was significantly associated when social frailty was restricted to social activity and contact with wider social networks (outside

of immediate family, such as neighbours).¹⁰³ Taken together, people living with frailty appear to have declining social participation and increasing loneliness over time, a decline in contact with wider social networks, and increases in the provision of social support (however, the perceived adequacy of support was not assessed in these studies).

Frailty, social vulnerability and clinical outcomes

23 studies assessed the joint associations of frailty and social vulnerability with clinical outcomes.^{16,26,29–32,45,48,63,67,73,78,84,85,89,95,98,99,106,115,122,129,130} These studies were heterogeneous in their aims and designs (appendix pp 6–10). Ten of these studies assessed mortality outcomes.^{16,30–31,32,45,48,73,84,115,130} In mutually adjusted models, four of four studies found that both higher frailty index scores and higher social vulnerability index were each associated with mortality, as did a further study assessing physical (frailty phenotype) and social frailty. However, a further study,³¹ also using the social vulnerability index, found that the association between social vulnerability and mortality was only observed in participants without frailty but not in participants with frailty. The association between frailty and mortality was found to be stronger in the presence of loneliness, social isolation, or social frailty.^{73,84} One study found that higher levels of social support appeared to be protective against mortality in the context of frailty.⁴⁸ Finally, one study found no evidence that social factors mediated the relationship between frailty and mortality.⁴⁵ Taken together, there is emerging evidence that social vulnerability might confer additional risk to the well-established relationship between frailty and mortality. However, this finding might not be the case for all measures and in all circumstances, and potential mechanisms remain unexplored.

Three studies assessed hospital or nursing home admission.^{26,84,130} Physical frailty, but not social frailty, was associated with hospital admission; instead, another study found that social frailty, but not physical frailty, was associated with nursing home admission. Finally, the association between social frailty and the combined endpoint of hospital or nursing home admission was found to be higher in pre-frail people, compared with robust people, with high uncertainty of association in the frail group.

Two studies retrospectively assessed falls, showing that frailty in combination with either social frailty or social isolation was associated with a history of falling; however, when assessed separately, frailty and social frailty were not significantly associated with falls.^{67,106}

Two studies assessed the association of both frailty and social vulnerability with incident disability in a mutually adjusted model.^{26,115} In one study, both the frailty index and social vulnerability index were associated with dependency in completing activities of daily living; however, in the other study, the physical domain of the

Groningen frailty indicator (mobility, comorbidity, physical energy, vision, and hearing) was significantly associated with disability, whereas the social domain (loneliness) was not. Four studies (two of them cross-sectional) showed that the association between frailty and disability was greater in the presence of social frailty, social isolation, or reduced social participation.^{98,106,122,129} A fifth study showed similar findings in people with pre-frailty, but the confidence intervals for the frail group included the null.⁸⁴ Overall, physical frailty was associated with declines in functional independence, with some evidence suggesting that this relationship is stronger in the presence of social vulnerability.

Two longitudinal studies, both using the frailty index and social vulnerability index, found that in a mutually adjusted model, both indicators were independently associated with a decline in cognitive function.^{29,32} Four cross-sectional studies suggested that the association between social frailty or social isolation with reduced cognitive function was strongest in people living with frailty; however, only two of these studies did formal statistical testing for interaction.^{89,94,98,106}

In two cross-sectional studies, frailty was associated with increased depressive symptoms, and this association was partly mediated by poor social support.^{78,99} The association between social isolation and depression was found to be stronger in the presence of frailty compared with pre-frail or robust states,⁹⁸ and the combination of physical and social frailty was associated with higher depressive symptoms than either state alone.¹⁰⁶

Both the frailty index and the social vulnerability index were associated with declining quality of life over 2 years, with no evidence of statistical interaction.⁶³ Another study showed a null association between the physical component of the Groningen frailty indicator and social frailty (defined using the social subscale of the Groningen frailty indicator), but this study was limited by a small sample size, short follow-up, and a non-validated quality of life measure.²⁶

Discussion

This systematic review of 130 observational studies showed that people with frailty were more likely to experience social vulnerability across a wide range of domains. Relationships between frailty and loneliness, and with composite measures (such as the social vulnerability index and social frailty), were consistent across the identified literature. Frailty was associated with social isolation (particularly isolation from wider networks outside immediate family), with lower social participation and with lower perceived adequacy of social support. While evidence suggests that frailty and social vulnerability have a bidirectional relationship, the body of evidence showing that social vulnerability is associated with worsening frailty is more developed. Although the literature on the joint associations of frailty and social vulnerability with clinical outcomes is relatively sparse

and heterogeneous, both frailty and social vulnerability have been shown to be independently associated with mortality, and the combination of frailty with social vulnerability is most strongly associated with increased functional limitations, cognitive impairment, and depressive symptoms.

The association between frailty and social vulnerability was seen across various frailty definitions, including measures based on a solely physical model of frailty. As such, our findings demonstrate the importance of assessing the broader social context in which frailty manifests. Our findings also illustrate the breadth and complexity of constructs that describe social vulnerability. Although frailty was associated with each of these constructs, they are not equivalent, nor are they interchangeable; this dissimilarity is exemplified by the apparent inconsistencies in findings for the relationship between frailty and social support, which might be driven (at least in part) by the distinction between support provision and the perceived adequacy of support. This breadth and complexity present challenges for how social vulnerability should be identified, quantified, and responded to. Establishing consistent definitions would be a useful direction for future research, requiring engagement with people experiencing social vulnerability as well as health-care professionals, social-care professionals, and policy makers.

Frailty and social vulnerability are global phenomena,^{3,6} with high prevalence and consistent associations found across different countries. The high prevalence rates, along with evidence of worse clinical outcomes when frailty and social vulnerability coincide, emphasise the importance of measures to address these phenomena. Identifying people living with frailty or social vulnerability is a prerequisite to tailored support and intervention.¹⁵³⁻¹⁵⁵ Our findings illustrate some of the many challenges in this area. The complexity and range of relevant domains that describe social vulnerability mean that focusing on a narrow domain (such as social networks) might overlook vulnerability in other domains (such as loneliness or scarcity of emotional support). Furthermore, assessments of degree of social support and perceived adequacy of support might not align. This complexity needs to be balanced against the practical implications of identifying people at risk within clinical settings, such as primary care, where time-consuming or burdensome measures are unlikely to be widely adopted within pressured systems. Integrating frailty identification into routine care has been facilitated by electronic medical record-based tools, such as the electronic frailty index, thereby allowing population risk stratification and targeted individual assessment.¹⁵⁶ Identifying social vulnerability might be a potentially feasible extension to frailty identification, and could be done either by deriving a social vulnerability index from existing structured assessments or by integrating brief screening questions (such as abbreviated loneliness questionnaires) into

existing templates.¹⁵⁷ Key considerations for the development and implementation of such tools include their length and usability and their acceptability to patients. These considerations should be priorities for future research. Health-care professionals and policy makers require robust evidence regarding which interventions have the potential to reduce social vulnerability, mitigate its adverse consequences, and support people experiencing social vulnerability. Interventions (such as care navigation or social prescribing) hold promise; however, findings have been mixed, with insufficient detailed assessments of implementation or cost-effectiveness.^{158,159}

Our findings demonstrate associations between social vulnerability domains and changes in frailty status. These relationships cannot be assumed to be causal, and might be susceptible to confounding or reverse causation. For example, social isolation might be a consequence of declining health, which could bias associations with subsequent changes in frailty. Both frailty and social vulnerability are dynamic, modifiable constructs, which (in some cases) might be reversible. The question remains whether interventions to modify frailty influence future social vulnerability, and whether interventions to modify social vulnerability affect subsequent frailty. To this end, intervention studies targeting frailty, or seeking to improve social vulnerability, should prospectively assess both constructs.¹⁵⁸ There is also a need to consider to what extent social vulnerability might reduce an individual's capacity to undertake activities that could reduce frailty (such as exercise or nutritional interventions). A further challenge is the long follow-up time required to assess meaningful changes in frailty trajectories (for example, the association between social isolation and deficit accumulation became more apparent over follow-up exceeding 10 years).^{44,54}

The strengths of this systematic review include a comprehensive search strategy and no language restrictions. However, due to a shortage of time and resources, we excluded grey literature, which could result in publication bias. The studies identified were almost exclusively from high-income or upper-middle-income countries, with a resulting scarcity of available estimates from lower-income countries. Similarly, models used to conceptualise both frailty and social vulnerability have been disproportionately validated in the Global North, despite most increases in population ageing projected to happen in the Global South. Our broad inclusion criteria allowed for inclusion of studies assessing a range of related, but distinct, constructs, and comparison of their findings, which would not have been possible with a narrower focus on specific frailty or social vulnerability domains; however, this heterogeneity precluded quantitative synthesis. Similar constructs were often measured using diverse measurement scales, limiting comparability of study findings. Furthermore, it was not always possible to disaggregate distinct aspects of

measures such as social support (eg, separating emotional from instrumental support).

Frailty, regardless of measure, is associated with social vulnerability across a range of domains. As societies and health-care systems seek to respond and adapt to increasing frailty at a population level, there is a need to respond to the individual-level social vulnerability that contextualises frailty. This response will require a careful balance of the multidimensional and complex nature of both frailty and social vulnerability with the need for practical tools and interventions that can be implemented into health-care settings. Although striking this balance presents considerable challenges, considering frailty or social vulnerability in isolation is unlikely to provide adequate responses to either.

Contributors

PH and EOH conceived the study. PH, ED, DLV, and EOH designed the protocol, developed the search strategy, and refined the inclusion criteria. PH, HW, MP, SK, and CJ screened titles and abstracts, developed the data extraction template, and carried out screening of abstracts and full texts, quality assessment, and data extraction. PH wrote the first draft. PH, HW, MP, SK, CJ, MKA, ED, DLV, and EOH critically reviewed the first and subsequent drafts. All authors approved the final version of the manuscript for submission. PH is the guarantor of the review. All authors accept accountability for the accuracy of the findings.

Declaration of interests

MKA reports research grants from GSK, Pfizer, Sanofi, Public Health Agency of Canada, COVID-19 Immunity Task Force, Canadian Institutes of Health Research (paid to the institution), past honoraria from Sanofi, past conference registration fees from GSK (part of a grant-funded project), and past honoraria for ad-hoc advisory activities from Sanofi, Pfizer, and Sequirus. MKA is also a voluntary member of Canada's National Advisory Committee on Immunization. All other authors declare no competing interests.

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