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Original Article

The prevalence of malnutrition (MUST and MNA-SF), frailty and physical disability and relationship with mortality in older care home residents

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SUMMARY

Background & Aims: Currently, there is lack of universal consensus on the use of effective malnutrition screening tools. Although malnutrition, frailty and physical disability are interrelated and associated with mortality in older people, there is a paucity of research in care home settings. With a high co-prevalence of these conditions, understanding their interconnectedness can provide a holistic view of an older person's health condition. The purpose of this study was to examine the prevalence of malnutrition (and risk) frailty and physical disability among care home residents using different methods, as well as the associations between markers of malnutrition (MUST and MNA-SF), physical function (Barthel Index, BI), frailty (Edmonton Frailty Scale, EFS), and all-cause mortality in care home residents.
Methods: In Lincoln, UK, 508 residents from care homes underwent screening for malnutrition (MNA-SF and MUST), frailty (EFS), and physical function (BI) as part of standard comprehensive geriatric assessment (CGA) between November 2015 and January 2018. Prevalence of conditions were assessed and MNA-SF, MUST, EFS, and BI-specific survival in each category were compared using Kaplan-Meier survival analysis (KMSA) with log-rank test. Multivariable analyses were conducted using the Cox proportional hazard model to identify prognostic factors that were statistically significant in care home residents.
Results: There was significant discordance between malnutrition risk measured by MUST and MNA-SF. The percentage of patients ‘at

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risk'/'medium risk' and 'malnourished'/'high risk' was 25.3%/49.9% for MNA and for 19.6%/31.57% for MUST. The prevalence of frailty measured by EFS was high with the percentage of residents with severe frailty being 70.9%. Only 8.6% of patients were functionally independent. The association between malnutrition risk (MUST) and mortality was not significant. MNA-SF appeared to be a better tool at predicting mortality in older care home residents ($p < 0.001$). Furthermore, the association between frailty (EFS) and mortality was significant ($p < 0.01$).

Conclusions: This study found high levels of malnutrition, frailty, and disability among UK care home residents, and a discordance between MUST and MNA-SF scoring patterns. The MNA-SF and EFS were better predictors of mortality than MUST and BI, highlighting the need for sensitive tools in assessing malnutrition and frailty risks in this population.

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Introduction

Malnutrition in older adults is increasingly recognised as a geriatric syndrome, defined by multifactorial aetiology, symptoms, poor prognosis [1], and co-prevalence with frailty, and sarcopenia, and physical disability [2]. It is important to screen accurately for malnutrition, frailty, and physical function/disability using simple tools in settings such as care homes, as this population is highly vulnerable, has higher than expected prevalence of malnutrition, frailty, and disability, and is currently under-researched with a lack of consensus on the most appropriate diagnostic tools to use in practice [3,4]. There are many types of nutrition screening tools available. The malnutrition universal screening tool (MUST), endorsed by BAPEN, is used in many hospitals and care homes in the United Kingdom (UK). The mini nutritional assessment and abbreviated short-form (MNA-SF) have been validated and are recommended for use in older people (>65 years) solely for assessing malnutrition risk [5]. Clinical and dietetic decisions are based in part on the results of nutritional screening instruments. There is some debate as to which tool is most accurate with frail older people, and indeed, previous reports suggest a possible discordance between MUST and MNA scoring patterns [6–8]; and the MUST may potentially under-report malnutrition risk [9–11].

Frailty, as outlined by Gobbens *et al.* [12], is an integral systemic manifestation comprising physical, psychological, and social weaknesses. These weaknesses encapsulate signs, symptoms, illnesses, and impairments that aggregate throughout an individual's lifespan. According to a systematic review and meta-analysis published in 2015, up to half of care home residents aged 60 or older were frail [13]. In this research, frailty was assessed using the Edmonton Frail Scale (EFS), a comprehensive tool that evaluates various aspects of health, including but not limited to physical function. It embraces a multidimensional concept of frailty, encapsulating cognitive, health attitude, social support, medication use, nutritional status, mood, continence, and functional and physical performance. This aligns with the definition of frailty proposed by Gobbens *et al.* [12], which posits frailty as a multidimensional construct encompassing physical, psychological, and social domains. This instrument has been validated in a variety of populations and has been increasingly used in clinical and research settings [14–19]. Additionally, frailty, especially when evaluated using comprehensive tools like EFS, is a significant predictor of mortality, as substantiated by previous systematic reviews [20–22]. Nonetheless, research specifically exploring the efficacy of EFS in care home settings remains limited, particularly regarding its applicability to older residents.

Physical disability co-relates with frailty, and may be a potential cause or consequence of frailty, with both being associated with increased mortality risk in recent studies [23,24]. The Barthel Index

(BI) is an ordinal scale used to measure performance in activities of daily living (ADL) and mobility. The validity of BI in measuring physical function and predicting mortality in older people has been established [25–27].

In summary, older adults living in care homes are commonly affected by malnutrition, frailty, and disability. These conditions, often occurring simultaneously, significantly impact their health outcomes, including survival. However, current practice often assesses these conditions separately, using different tools that may not provide a comprehensive overview of the patient's health status. Further, the lack of consensus on an effective universal malnutrition screening tool limits the comparability of available research and influences intervention trials. Consequently, the aims of this study are as follows: A) to examine the prevalence of malnutrition, frailty and physical disability among care home residents using different methods; B) to determine which of the screening tools used predicts prognosis better, and C) to further examine the differences between the MUST and MNA-SF malnutrition screening patterns.

Method

Participants and study design

The original data of this observational study was collected between November 2015 and January 2018 on 508 residents of 15 care homes in Lincoln, United Kingdom (UK), as part of an ongoing assessment of care home services [28]. Dr. Gill Garden led a multidisciplinary team of healthcare experts (Medical Consultant, Nurses, Occupational Therapist, Physiotherapist and Registered Nutritionist) in conducting a Comprehensive Geriatric Assessment (CGA) on each participant. As part of the CGA, trained healthcare professionals conducted a thorough review of the care home and general practice clinical records. Through this review and by taking a full medical history, comorbidities such as diabetes, cancer, cardiovascular disease, chronic heart failure, chronic kidney disease, chronic obstructive pulmonary disease, arthritis, and dementia were identified. Only individuals having full MNA-SF, EFS, and BI scores were included in the analysis, which resulted in the exclusion of 17 residents from the total of 508 patients. Thirty-three individuals received approximated MNA-SF and MUST scores due to the inability to precisely measure their weight and/or height for BMI as a result of their severe disability.

Anthropometric measurements

As part of CGA, body weight (kg) and height (m) were assessed using weighing scales and stadiometers. When height could not be accurately measured, it was calculated based on ulnar length using the British Association of Parenteral and Enteral Nutrition (BAPEN) conversion tables included in the MUST tool instructions [29]. Body mass index (BMI) was calculated in kg/m^2.

Assessment of nutrition status

The nutritional risk status was evaluated using the validated MUST and MNA-SF screening instruments in accordance with published guidelines [5,30,31]. The final MUST score ranges from 0 to 6, with 0 indicating a low/normal risk, 1 medium risk, and 2 or more indicating high risk of malnutrition. The final MNA-SF score ranges from 0 to 14 and were categorised as follows: 0–7 malnourished, 8–11 at risk of malnutrition, and 12–14 normal nutritional status.

Assessment of frailty

The Edmonton Frailty Scale (EFS) is composed of the nine frailty domains comprising cognition, continence, general health status, functional independence, mood, medication use, social support, nutrition and functional performance [32]. It has a maximum score of 17, with a minimum total score of 0. It can be categorised as: not frail (0–7), mild (8–9), moderate (10–11), and severe (12–17) frailty.

Assessment of physical function

The Barthel Index (BI) is an ordinal scale comprised up of 10 ADL, including grooming, toilet use, mobility, dressing, bowel movement, stairs, bladder continence, feeding, transfer, and bathing [27]. The index developed by Collin and Wade [33] underwent a widely accepted update that included a new score range of 0–20, where the lower the score, the greater the physical impairment. Subjects were categorised; <3 total dependency, 3–11 high dependency, 12–17 mild dependency, and 17–20 functional independent.

Statistical analysis

Continuous variables were reported as mean standard deviation (SD) or median and range (minimum–maximum). Q-Q plots were used to examine the distributional normality of continuous data. The prevalence was measured by calculating the number of residents and the percentage of the population. Chi-square tests were conducted to examine the significant difference between categorical variables, independent t-test were conducted in continuous variables. Kaplan-Meier survival analysis (KMSA) method was used to involve generating tables and plots of the survival or the hazard function for the event history data. The log-rank test was used to indicate whether survival between groups is significantly different. Backward-stepwise Cox proportional hazard regression models were used to examine the probability of death happening during the follow-up time. Multivariable model selection was based on the Akaike information criterion (AIC), Bayesian information criterion (BIC), and the results of univariate analysis. Two independent multivariable Cox regression models were created, with all-cause mortality as the dependent variable and the MUST or MNA-SF as the independent variable to avoid collinearity. The collected data were imported into Microsoft Excel and analyzed with Stata Statistical Software: Release 17. A p-value of < 0.05 was considered to be statistically significant.

Results

Participant characteristics

491 older people from 15 care homes in Lincoln were evaluated. Table 1 displays the sample's characteristics. 491 residents had their MNA-SF, EFS, and BI done, 494 had BMI completed, and 505 had MUST completed. Mean and standard deviation were used to represent regularly distributed datasets. The percentage of relative standard error (SEM mean) was used to assess the reliability of data, with values of 20% being regarded as accurate. We conducted an independent samples t-test to compare the mean age between individuals who were dead ($n = 440$) and alive ($n = 51$). The results revealed a significant difference in the mean age between the two groups ($t\ (df) = -3.7\ (488)$, $p < 0.001$). In addition to age, other demographic and clinical characteristics, such as BMI, MUST, and MNA-SF, were not associated with the mortality status of the CGA cohort ($p > 0.05$), as indicated by the Chi-square tests. However, EFS and BI demonstrated different results across categories, according to the Chi-square tests (Table 1).

Assessment of malnutrition and malnutrition risk

Using the MNA-SF and the MUST, the proportion of people who were severely malnourished or at high risk was 49.9% and 25.3% respectively, while the percentage at risk or at medium risk was 31.57% and 19.6%, respectively. Those who had normal nutritional status or were at low risk of malnutrition were measured by the MUST at 55.2% and the MNA-SF at 18.5%. Chi-square analyses revealed that the malnutrition status assessed by MNA-SF was significantly different from those assessed by MUST in each classification ($\chi 2 = 177.08$, $df = 4$, $p < 0.01$). The data demonstrated the disparity between the screening tools. Figure 1 illustrates the prevalence of malnutrition and the discrepancy between the MNA-SF and MUST.

Table 1
Demographic and clinical characteristics of the Comprehensive Geriatric Assessment (CGA) cohort stratified by mortality at died or survived during the follow-up period.

Characteristics	Total ($N = 491$)	Dead ($N = 440$)	Alive ($N = 51$)	χ2	*p* value
Age (yrs.)	85.6 ± 7.6	86.0 ± 7.2	81.9 ± 10.0	-	<0.001*
BMI					
Underweight	94 (19.1)	88 (20.0)	6 (11.8)	2.00	0.157
Normal weight	248 (50.5)	224 (50.9)	24 (47.1)	0.27	0.603
Overweight	108 (22.0)	94 (21.4)	14 (27.5)	0.99	0.320
Obese	41 (8.4)	34 (7.7)	7 (13.7)	2.15	0.143
MUST					
High risk	124 (25.3)	113 (25.7)	11 (21.6)	0.41	0.522
Medium risk	96 (19.6)	90 (20.5)	6 (11.8)	2.19	0.139
Low risk	271 (55.2)	237 (53.9)	34 (66.7)	3.03	0.082
MNA-SF					
Malnourished	245 (49.9)	224 (50.9)	21 (41.2)	1.73	0.188
Malnutrition	155 (31.6)	138 (31.4)	17 (33.3)	0.08	0.774
Normal Status	91 (18.5)	78 (17.7)	13 (25.5)	1.82	0.177
EFS					
Severe frailty	348 (70.9)	318 (72.3)	30 (58.8)	4.00	0.045*
Moderate frailty	81 (16.5)	73 (16.6)	8 (15.7)	0.03	0.869
Mild frailty	45 (9.2)	35 (8.0)	10 (19.6)	7.46	0.006*
No frailty	17 (3.5)	14 (3.2)	3 (5.9)	0.99	0.318
BI					
Total dependent	160 (32.6)	147 (33.4)	13 (25.5)	1.30	0.253
HD	184 (37.5)	172 (39.1)	12 (23.5)	4.72	0.030*
MD	105 (21.4)	89 (20.2)	16 (31.4)	3.38	0.066
FI	42 (8.6)	32 (7.3)	10 (19.6)	8.89	0.003*

Values are n (%) unless specified. Categorical values are expressed as the percentage (%) of patients; continuous values are expressed as the mean ± SD. BMI = body mass index; MNA-SF = mini nutrition assessment and abbreviated short-form; MUST = malnutrition universal screening tool; EFS = Edmonton Frail Scale; BI = Barthel Index; HD = high dependency; MD = mild dependency; FI = functional independent; * indicate statistically significantly ($p < 0.05$).

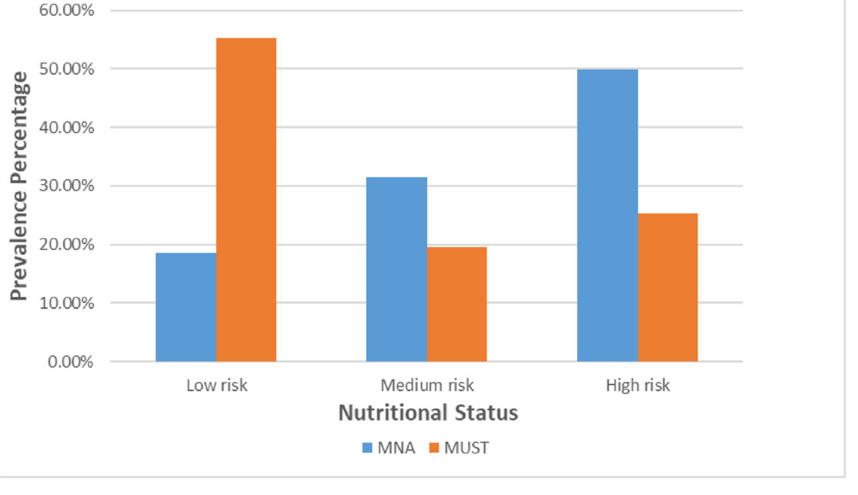

Figure 1. Malnutrition prevalence (%) by MNA-SF and MUST. Low risk/normal; medium risk/at risk; high risk/malnourished.

Associations between malnutrition, frailty, disability and mortality

Survival analysis was conducted between nutrition status (MNA-SF, MUST), frailty (EFS), disability (BI) and all-cause mortality between 2015-2018. Survival times were represented graphically by survival curves, calculated by the Kaplan-Meier method. Figure 2 shows the Kaplan-Meier plot of each parameter. The overall median and mean survival time of 491 care home residents were 492 days and 756 days. In terms of MUST, the median survival time of “low risk”, “medium risk”, and “high risk” groups was 713, 346 and 294 days, respectively. For MNA-SF, the median survival times of “no malnutrition”, “risk of malnutrition”, and “malnutrition” group were 763, 696 and 336 days, respectively. In terms of the prognostic relevance of frailty in survival analysis, it is worth noting that the survival probability of the ‘not frail’ group decreased more rapidly than those in the ‘moderate frail’ and ‘mild frail’ groups. The median survival times of “mild frailty”, “moderate frailty”, “not frail”, and “severe frailty” group were 1043, 962, 588 and 397 days, respectively. The median survival times of “functional independent”, “mild dependency”, “high dependency”, and “total dependency” groups were 918, 936, 537 and 341 days, respectively. The log-rank tests for survival analysis indicates that the survival between groups within each parameter is significantly different ($p < 0.001$).

To examine the association between the scores on their original continuous scale, and survival time, the Cox regression test was conducted. The survival time would be the outcome variable, and the predictor (independent) variable would be age, BMI, MNA-SF, MUST, EFS, and BI scores. The hazard ratio of multiple measured variables reported in Table 2.

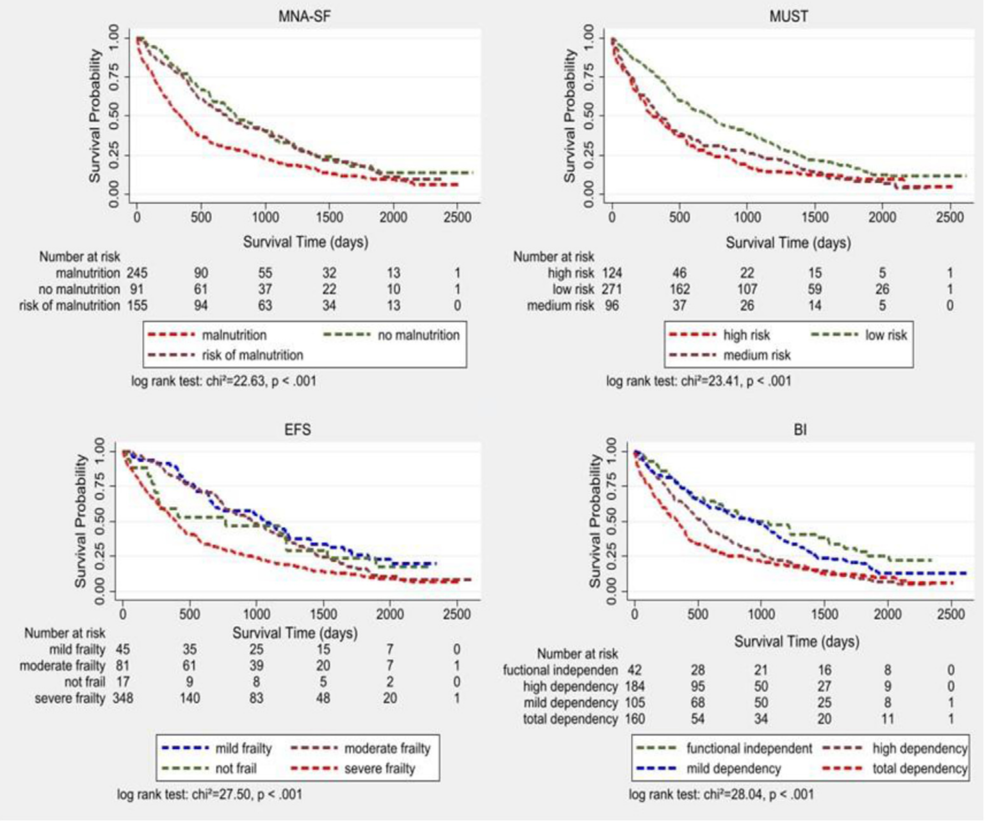

Figure 2. Kaplan-Meier Survival Curves for Nutritional Status measured by MNA-SF and MUST, Frailty measured by EFS, and Physical Disability measured by BI.

Table 2
Hazard ratios from Cox regression analysis of variables associated with all-cause mortality among care home residents in Lincoln, UK ($N = 492$).

Variables	Univariate			Multivariate		
	HR	95% CI	*p*-value	*HR*	95% CI	*p*-value
Age	1.03	1.01–1.04	0.000*	1.02	1.01–1.04	0.002*
BMI	0.97	0.95–0.99	0.001*	1.00	0.98–1.03	0.74
EFS	1.16	1.11–1.21	0.000*	1.09	1.03–1.17	<.001*
BI	0.96	0.95–0.98	0.000*	0.34	0.97–1.01	0.34
MNA-SF	0.92	0.89–0.94	0.000*	0.96	0.92–0.99	0.019*
MUST	1.15	1.09–1.22	0.000*	1.07	0.99–1,14	0.07

* indicate factors significantly related to mortality ($p < 0.05$).

Table 2 shows models revealing the association between demographic characteristics (age, BMI), frailty, physical function, nutrition status (MUST, MNA-SF) and survival time. All covariates in univariate Cox regression model were statistically significant. After adjusting for age, EFS, BI and MNA-SF scores in multivariate analysis (Table 2), the association did not remain statistically significant for BMI, BI and MUST scores. There was an 4.2% reduction in the risk of death for each point increase in the patient's MNA-SF score (95% CI: 1.7%, 7.5%; $p < 0.05$). MNA-SF appeared to be the better tool to predict survival time in care home residents in the current multivariate Cox regression model. For physical disability, there was no significant correlation between BI scores and death in multivariate analysis. However, each point increased of the EFS score was associated with a significantly increase as 9.3% (95% CI: 3.0%, 16.1%; $p < 0.001$) in the risk of the death in multivariate analysis.

Discussion

This project was part of an observational study of unselected care homes in Lincoln, UK which was an ongoing assessment of care home services as part of a clinical service evaluation. Therefore, this has high importance indicating ‘real-world’ data trends that might be extended to the whole health and social care in the UK.

Comparison of MUST and MNA-SF malnutrition risk screening

It is no surprise that there was a high incidence of malnutrition risk, physical disability, and frailty in care home residents [28]. These findings are supported by other studies [2,34–36]. With regards to malnutrition risk, the proportion of people who were severely malnourished or at high risk was 49.9% and 25.3%, while the percentage of people at risk or at medium risk was 31.57% and 19.6% by MNA-SF and MUST, respectively. Those with normal nutritional status or at low risk of malnutrition were measured by the MUST at 55.2% and the MNA-SF at 18.5%. The prevalence of malnutrition (from screening tool scores) in care homes appeared high, which is consistent with previous studies conducted in the same setting [37–40]. There appears to be a mismatch between the MNA-SF and MUST scoring systems, leading to different prevalence of malnutrition risk for different tools (Figure 1). Recent studies also demonstrated the MUST tool, considered the gold standard for evaluating malnutrition risk in older inpatients in the UK, deviated from the MNA-SF tool [6–8]. The mismatch between the malnourishment recognised by MNA-SF and MUST has important clinical implications since underreporting of malnourished frail older people may impact adversely on dietetic referral and appropriate nutritional intervention.

Comparing MUST and MNA-SF it is evident that these two tools assess malnutrition risk from distinct angles, and they comprise different sets of indicators (see Supplementary Figures 1 and 2). While MUST focuses exclusively on physical parameters such as body mass index (BMI), unexpected weight loss, and the effects of acute disease, the MNA-SF adopts a more holistic approach, including questions about mobility, neuropsychological issues (e.g., depression and dementia), as well as the presence of psychological stress and acute disease. These are indeed key components which overlap with frailty itself and other groups have actually shown that the MNA-SF predicts pre-frailty and frailty [41,42]. Moreover, the MNA-SF uses a different BMI scaling system and a higher cut-off point to indicate malnutrition. It's worth noting that this higher cut-off point is consistent with the current recommendations by the Global Leadership Initiative on Malnutrition (GLIM) criteria [43], e.g. a low BMI is indicated under 22 kg/m^2, for an over 70 year old person in Europe. Overall, this enables the MNA-SF to capture the elements that could contribute to malnutrition risk which are not included in the MUST assessment. The discrepancy between these tools reflects their divergent conceptual frameworks for understanding malnutrition, which subsequently may lead to differing prevalence rates of malnutrition risk when using MUST or MNA-SF. It is important to consider these differences when interpreting the results from each tool and deciding on their application in various settings.

In short, a discrepancy exists, and it remains controversial as to which tool is a more sensitive and suitable for screening for malnutrition in frail older people. A study by Slee *et al.* applied bioelectrical impedance assessment (BIA) of fat free mass index, FFMI (in kg/m^2) as a reference and corresponding matches with MUST/MNA-SF categorization. Overall, the MNA-SF screening results seemed to be more consistent with the BIA data [11]. This finding justifies use of the MNA-SF as a more sensitive instrument [11], which is consistent with another study by Slee *et al.* [44]. However, there have been conflicting findings: a study from Korea with 141 participants reported that MUST seemed to be the most valid and effective screening test for predicting malnutrition in the older adults at a hospital specialising in geriatric care, when compared to several tools including the MNA. The sensitivity, specificity, and positive and negative predictive values were calculated to establish the most reliable screening technique for predicting malnutrition [45].

This study provides crucial insights into the relative efficacy of the MUST and MNA-SF screening tools in predicting mortality among care home residents. Because this study was implemented in unselected care homes in a whole health and social care system, the demonstration of differences between the MUST and MNA-SF in identifying malnutrition and predicting prognosis in care home residents is important, as the findings challenge the appropriateness of ongoing use of MUST in this population. Our findings suggest that the MNA-SF may be a more sensitive instrument for assessing malnutrition risk in this population and more closely associated with mortality, which concurs with the results of other studies [46–49]. Our study with a much larger sample size supports the superiority of MNA-SF as a predictor of mortality. This information could inform healthcare providers' decisions on which tool to employ when assessing care home residents, potentially leading to more accurate risk assessments and more effective interventions. However, the disparity between the MNA-SF and MUST tool outcomes underscores the need for further research. Future studies could explore the reasons for these discrepancies and their implications for malnutrition risk assessments. Further studies should be performed to compare these tools with the currently suggested GLIM consensus criteria for malnutrition [43].

The association of frailty and physical function with mortality

The high prevalence of severe frailty (70.9%) found in this study is in line with findings of other studies using the EFS [50,51]. Frailty is a strong predictor of mortality for older care home residents in this study. One recent study indicated that EFS has a good predictive ability in older patients undergoing cardiac surgery or after fracture neck of femur [52,53]. EFS has also been shown to be best able to predict all-cause mortality in general medical patients when compared to seven other tools to measure frailty [54]. However, a recent study indicated that the frailty index (FI) demonstrated superior prediction of mortality to EFS [55]. It suggests the need for more research comparing different frailty assessment tools and their prognostic value. To date, there has been little research comparing frailty assessment tools as predictors of prognosis.

Total or high dependency was present in 70.1% of the participants. The assessment of functional status has garnered increasing attention as a core component of CGA in recent years. Physical function may forecast health-related adverse outcomes, including mortality in older people [56,57]. Previous research has typically found a strong link between functional status, as measured by BI, and comorbidity unrelated to hospital admission, with both being major risk factors for mortality in older people [58]. This was corroborated by a national Danish cohort study, which showed that BI at admission was independently related to mortality in older individuals [59]. Despite these consistent findings, the association between physical function and mortality was not as prominent in our study, diverging from the commonly observed pattern in the literature. Several explanations may account for this discrepancy, including differences in study design, variability in measurement tools, presence of different confounding factors, or publication bias. This discrepancy calls for more in-depth studies to better understand the role of functional status as a mortality predictor in older care home residents.

Limitations

Although our study provides valuable insights into the prevalence of malnutrition, frailty, and physical function in care home residents and relationship with mortality, it is not without limitations. Firstly, a larger sample size would have been preferable. Potential participants might be omitted due to difficulties communicating, absence of nutritional information, or those too ill to undergo nutritional assessment. It may also be difficult to precisely measure weight and height in care home residents, leading to measurement errors. It is hard to assess the impact of confounding factors such as cognitive function, medication and the presence of comorbidities which will affect both frailty and mortality [60]. Last, it would have been ideal to have validated measures of body composition available (e.g. BIA and DEXA), routine blood markers (e.g. C-reactive protein and albumin) and physical strength/function (e.g. hand grip strength). However, due to practical constraints inherent in care home settings, it was impossible to obtain these measures for every participant. Consequently, although our findings may not fully capture the complexity of malnutrition, frailty and physical function in this population, it was a large service evaluation conducted in an unselected population and as such the results are relevant to routine practice.

Conclusion

This study has provided essential information on the risk of malnutrition, frailty, and disability among care home residents in the UK. The prevalence of malnutrition risk was found to be high, and there was a notable discrepancy between the MNA-SF and MUST scoring patterns. Using the EFS and BI as screening tools, frailty and physical disability were highly co-prevalent. MNA-SF and EFS, rather than MUST and BI, were found to be strong predictors of all-cause mortality. It is essential to perform future evaluations of these and other related screening tools in the care home setting as this is an under-researched area of study and may impact trajectory of health and mortality.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.nutos.2023.08.007.

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