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MALNUTRITION IN HOSPITALISED OLDER ADULTS: A MULTICENTRE OBSERVATIONAL STUDY OF PREVALENCE, ASSOCIATIONS AND OUTCOMES

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Abstract: *Background:* Malnutrition is common in older adults and is associated with high costs and adverse outcomes. The prevalence, predictors and outcomes of malnutrition on admission to hospital are not clear for this population. *Design:* Prospective Cohort Study. *Setting:* Six hospital sites (five public, one private). *Participants:* In total, 606 older adults aged 70+ were included. All elective and acute admissions to any speciality were eligible. Day-case admissions and those moribund on admission were excluded. *Measurements:* Socio-demographic and clinical data, including nutritional status (Mini-Nutritional Assessment – short form), was collected within 36 hours of admission. Outcome data was collected prospectively on length of stay, in-hospital mortality and new institutionalisation. *Results:* The mean age was 79.7; 51% were female; 29% were elective admissions; 67% were admitted to a medical specialty. Nutrition scores were available for 602/606; 37% had a 'normal' status, 45% were 'at-risk', and 18% were 'malnourished'. Malnutrition was more common in females, acute admissions, older patients and those who were widowed/ separated. Dementia, functional dependency, comorbidity and frailty independently predicted a) malnutrition and b) being at-risk of malnutrition, compared to normal status ($p < .001$). Malnutrition was associated with outcomes including an increased length of stay ($p < .001$), new institutionalisation ($p =<0.001$) and in-hospital mortality ($p < .001$). *Conclusions:* These findings support the prioritisation of nutritional screening in clinical practice and public health policy, for all patients ≥70 on admission to hospital, and in particular for people with dementia, increased functional dependency and/or multi-morbidity, and those who are frail.

Key words: Malnutrition, epidemiology, hospitals, risk factors, screening.

Background

The number of older adults globally is set to triple from 605 million to two billion by 2050 (1). This increase will necessitate substantial developments in care quality across healthcare services for this population. Malnutrition, frequently defined as 'a state of nutrition in which a deficiency, or excess, of energy, protein and micronutrients causes measurable adverse effects on tissue/body form and function, and clinical outcomes' (2), is a significant issue for older adults. This is in part due to the increased presence of comorbid chronic conditions, heightened risk of acute diseases and poorer adaptation to inflammatory-catabolic states (3).

Malnutrition is common across healthcare settings for this population (3). The associated healthcare costs are substantial, estimated at €1.4 billion per annum in Ireland, with much of the cost attributable to hospital care (4). In hospitals, malnutrition is associated with adverse outcomes including an increased length of stay (LOS), mortality and institutionalisation (5).

The National Institute for Health and Care Excellence (NICE) guidance indicates that all hospital inpatients should have a nutritional status screen on admission (6), however there is evidence that this does not occur in practice (7). A number of barriers to providing good quality nutritional care have been identified including lack of knowledge/skills, poor communication, managerial decision-making and prioritisation of nutrition, as well as resource constraints (8, 9). A Brazilian study reported that just 19% of 4000 medical records recorded patients' nutritional status (10). Poor recognition of malnutrition has also been reported, with nurses missing up to 42% of cases (n = 1043) (11) and doctors' recognition, while better than medical students' and nurses', is still 'inadequate' (12).

The prevalence of malnutrition among older adults in hospitals is currently estimated at 4-40%, (13-15) while female sex, cognitive impairment, multi-morbidity and lower functional status have been identified as correlates of malnutrition on admission (13, 16). It must be noted however, that the existing research in this area is limited methodologically, as indicated by the wide variation in prevalence estimates; many studies are based on small samples and/or narrowly-defined populations, exclude people with dementia (PwD), sample just one site, and/or use tools not designed for use with older adults.

The prevalence and correlates of malnutrition in older adults on admission to hospital have been under-investigated in Europe, and have not been investigated in Ireland. The present study addresses this gap, while addressing the above-mentioned limitations of previous studies.

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Methods

The methods have been described in detail elsewhere (17). This prospective cohort study was conducted across five public and one private hospital in the Republic of Ireland. All elective and emergency admissions, aged ≥70 years were eligible, including those with dementia. Patients with reduced consciousness or aphasia were included. Only day-case admissions and those moribund on admission were excluded.

Tools & Procedure

Admissions were identified daily from admission lists, Emergency Department lists and a 'walk around' of wards. Two weeks of recruitment occurred per hospital, capturing each day twice, staggered over a 6-week period, between May 2012 and February 2013. All patients were enrolled within 36 hours of admission. All data collectors received training in the assessment tools at the outset, and completed a refresher session mid-study.

Patients' demographic information was recorded, along with hospital and admission characteristics including hospital location/type, admission type (acute/elective), and the specialty of the admitting team. The presenting illness was recorded from case notes, supplemented by the Hospital In-Patient Enquiry (HIPE) discharge data-set if the diagnosis was unclear. HIPE data is standardised nationally and is classified using the International Classification of Diseases, 10th revision (18). Nutritional status was determined by the revised short-form Mini-Nutritional Assessment (MNASF-R) (19). This has been validated against the original Mini-Nutritional Assessment tool across healthcare settings (19). It has six sections: A) food intake; B) weight loss; C) mobility; D) psychological stress and/or acute disease; E) neuropsychological problems; and F(1) body mass index (BMI), or F(2) calf circumference (when BMI parameters are not available). It has a three-category scoring system, based on the total scores (ranging from 0-14); 'normal' (12-14), 'at risk' (8-11) and 'malnourished' (0-7). Dementia was diagnosed using a three-step process, employing the Standardised Mini-Mental State Examination (MMSE) (20), followed by the Informant Questionnaire on Cognitive Decline in the Elderly (21), where scores were ≤27/30. Dementia status was ultimately established by the senior author (SuT), and in difficult to assign cases, by consultation with an expert panel. Dementia severity was rated by the Clinical Dementia Rating (CDR) scale (sum-of-boxes method) (22). The Cumulative Illness Rating Scale-Geriatrics rated comorbid disease burden across 13 items, scored from 0 (no problem) to 4 (extremely severe) (23). Patients were categorised as normal, pre-frail or frail using the SHARE-FI tool (24). Functional ability was rated by the Barthel Index (BI) Activity of Daily Living tool (25). The Waterlow scale (26) assesses pressure sore risk; total scores are categorised into low-risk (<10), at-risk (10-14), high-risk (15-19), and very high-risk (>20).

There were follow-up assessments every 48 hours for the first 10 days of the admission, then weekly for the first month, then monthly until discharge or death. Follow-up information collected includes in-hospital mortality, LOS and new institutionalisation post-discharge.

Data were analysed using SPSS software version 22. The differences between groups (based on MNA-SF) were assessed using the $\chi 2$ test for categorical variables and one-way ANOVA (normal distribution) or Kruskal-Wallis (non-normal distribution) tests for continuous variables. Multinomial logistic regression models examined the effect of various factors on nutritional status. The coefficient of determination (Nagelkerke R2) estimated the proportion of variation explained by the final model. Multicollinearity was investigated using the variance inflation factor (VIF) and tolerance values. A P value of <0.05 was considered statistically significant for this analysis.

Table 1
Sample Demographic Characteristics

Variable		n (%)
Gender	% Female	311 (51.3)
Age, median (IQR)	79 (10)	
Education	Primary (≤8 years)	203 (35.1)
	Inter Cert' (9-11 years)	167 (28.8)
	Leaving Cert' (12-13 years)	132 (22.8)
	Tertiary (>13 years)	77 (13.3)
Marital status	Never married	71 (11.7)
	Married	270 (44.6)
	Widowed/separated	265 (43.7)
Smoking status	None	305 (51.5)
	Current	44 (7.4)
	Ex	243 (41.1)
Alcohol intake	Never	215 (36.3)
	Previous drinker (no excess)	78 (13.2)
	Drinker excess (pre/curr)	35 (5.9)
	Current drinker (no excess)	264 (44.6)
Home type	Home alone	176 (29)
	Home with others	376 (62.1)
	Nursing home	35 (5.8)
	Sheltered accommodation	19 (3.1)
Supports	None	170 (29.8)
	Family alone	208 (36.4)
	Outside supports	193 (33.8)
Hospital	%Urban (vs rural)	507 (83.7)
Admission	%Acute (vs elective)	431 (71.1)
Speciality	Medical	403 (66.6)
	Surgical	128 (21.2)
	Geriatric/orthopaedic	74 (12.2)

Table 2
Demographic Status of Participants, According to Nutritional Status

Demographic Information		Normal n (%) n=222	At-Risk n (%) n=274	Malnourished n (%) n=106	Statistic	df	P-value
Gender	Male	122 (55)	130 (47.4)	40 (37.7)	χ^2= 8.74	2	0.013
	Female	100 (45)	144 (52.5)	66 (62.3)			
Age, mean (SD)		77.96 (5.9)	80.48 (6.5)	81.58 (7.4)	F= 14.56	2, 599	<0.001
Education	Primary (≤8 years)	56 (25.9)	92 (35.4)	54 (54.5)	χ^2= 40.8	6	<0.001
	Inter Cert' (9-11 years)	55 (25.5)	82 (31.2)	30 (30.3)			
	Leaving Cert' (12-13 years)	62 (28.7)	59 (22.4)	10 (10.1)			
	Tertiary (>13 years)	43 (19.9)	29 (11)	5 (5.1)			
Marital Status	Never married	17 (7.7)	42(15.3)	12 (11.3)	χ^2= 25.49	4	<0.001
	Married	127 (57.2)	99 (36.1)	41 (38.7)			
	Widowed/separated	78 (35.1)	133 (48.5)	53 (50)			
Smoking Status	None	111 (50.5)	139 (51.7)	54 (53.5)	χ^2= 6.28	4	0.179
	Current	11 (5)	21 (7.8)	12 (11.9)			
	Ex	98 (44.5)	109 (40.5)	35 (34.7)			
Alcohol intake	Never	67 (30.6)	102 (37.9)	46 (45.1)	χ^2= 46.83	6	<0.001
	Previous drinker (no excess)	15 (6.8)	40(14.9)	23 (22.5)			
	Drinker excess (prev/current)	7 (3.2)	18 (6.7)	10 (9.8)			
	Current drinker (no excess)	130 (59.4)	109 (40.5)	23 (22.5)			
Home type	Home alone	60 (27)	93 (33.9)	22 (20.8)	χ^2= 33.27	4	<0.001
	Home with others	157 (70.7)	152 (55.5)	64 (60.4)			
	Nursing home/Sheltered	5 (2.3)	29 (10.6)	20 (18.9)			
Supports	None	105 (47.3)	56 (21.7)	8 (9.2)	χ^2= 62.36	4	<0.001
	Family alone	70 (31.5)	98 (38)	37 (42.5)			
	Outside support	47 (21.2)	104 (40.3)	42 (48.3)			
Hospital	Urban	192 (86.5)	224 (81.8)	87 (82.1)	χ^2= 2.21	2	0.332
	Rural	30 (13.5)	50 (18.2)	19 (17.9)			
Admission	Acute	145 (65.3)	197 (71.9)	88 (83)	χ^2= 11.07	2	0.004
	Elective	77 (34.7)	77 (28.1)	18 (17)			
Speciality	Medical	143 (64.4)	191 (69.7)	66(62.3)	χ^2= 28.03	4	<0.001
	Surgical	61 (27.5)	54 (19.7)	13 (12.3)			
	Geriatric/Orthopaedic	18 (8.1)	29 (10.6)	27 (25.5)			

Results

During recruitment, 676 adults ≥70 were approached, however 52 refused to participate, 7 were critically-ill and 11 were discharged pre-screening. Thus, 606 patients were included. Sample characteristics are detailed in Table 1. Briefly, the median age was 79 (IQR = 10) and the mean was 79.7 (SD= 6.6); 51.3% (n=311) were female; 28.9% (n=175) were elective admissions to hospital; 66.6% (n=403) were admitted to a medical speciality. Dementia status could not be determined in eight individuals (see Timmons et al., 2015 for diagnostic pathway for dementia), and of the remaining 598 patients, 149 (24.9%) were diagnosed with dementia. In terms of dementia severity, 55% of cases were mild, 29% moderate and 16% severe.

MNASF-R nutritional status scores were available for 602/606 patients on admission to hospital: 36.9% (n=222) were considered to have 'normal' nutritional status, 45.5% (n=274) were 'at-risk' of malnutrition, and one-in-five (17.6%, n=106) were 'malnourished'. The mean BMI was 28.06 (SD

Table 3
Clinical Parameters Associated with Nutritional Status

Clinical Characteristics		Normal n(%) n=222	At-Risk n(%)n=274	Malnourished n(%) n=106	Statistic	df	P-value
Dementia							
	Yes	11 (5)	81 (30.1)	56 (54.4)	$\chi^2 = 98.92$	2	<0.001
	None	211 (95)	188 (69.9)	47 (45.6)			
CIRS-G, median [Q1–Q3][a]		8 [5]	10 [6]	12 [8]	H = 52.12	2	<0.001
	Mean Ranks	243.5	315.59	386.57			
Barthel Index, median [Q1-Q3][a]		20 [2]	18 [7]	11 [13]	H = 143.38	2	<0.001
	Mean Ranks	392.56	281.95	161.32			
SHARE-FI							
	Non-frail	42 (47.7)	30 (27)	3 (6.1)	$\chi^2 = 54.46$	4	<0.001
	Pre-frail	30 (34.1)	25 (22.5)	6 (12.2)			
	Frail	16 (18.2)	56 (50.5)	40 (81.6)			
Waterlow							
	No risk	129 (58.1)	107 (39.2)	11 (10.4)	$\chi^2 = 105.19$	4	<0.001
	At risk	75 (33.8)	97 (35.5)	37 (34.9)			
	High risk	18 (8.1)	69 (25.3)	58 (54.7)			

a = interquartile range

= 5.21), and the median was 27.5 (IQR=6.7), with a minimum of 15.40 and maximum of 51.10. The majority (80.9%, n=487) had a BMI of ≥23. Demographic and clinical characteristics of the sample are outlined by nutritional status in tables 2 and 3 respectively, along with univariate analyses.

As seen in table 2, a one-way analysis of variance indicated a significant effect of age on nutritional status; Tukey post-hoc tests revealed that those who were malnourished or at-risk on admission were significantly older than those who had normal nutritional status, with no statistically significant difference between those who were malnourished and those who were at-risk. Similarly, there was a significant effect of comorbidity on nutritional status. Post-hoc Mann-Whitney tests with the Bonferroni correction, showed that differences exist across all three groups; those who have a normal nutritional status have lower comorbidity scores than those who are at-risk ($p<0.001$) and those who are malnourished ($p<0.001$) on admission, and that those who are at-risk, have lower comorbidity scores than those who are malnourished ($p <0.001$).

As illustrated in table 4, four parameters were independent predictors of nutritional status on admission (χ^2 (12) = 241.74, $p < .001$); dementia, greater comorbidity, greater functional dependence, and frailty. The coefficient of determination (Nagelkerke R^2) for this model was 38%, indicating that these four variables notably influence malnutrition on admission to hospital. Multicollinearity was assessed using the VIF and tolerance values; VIF values ranged from 1.1-2.2, while tolerance values ranged from 0.46-0.91, indicating collinearity is not present in this model (27). These four parameters predicted those who were at-risk of malnutrition, and those who were malnourished on admission. Of note, being "pre-frail" did not predict malnutrition/risk of malnutrition, only being "frail".

In terms of outcomes, nutritional status was associated with LOS ($p<.001$), in-hospital mortality ($p<.001$), and institutionalisation ($p<.001$) (see table 5). Post-hoc Mann-Whitney tests, with Bonferroni corrections, revealed an increased LOS in both those who were malnourished ($p < .001$) and those who were at-risk ($p = 0.001$), compared to the normal group. Those who were at-risk were more likely to die in hospital than those who scored normal, while those who were malnourished were most likely to die in hospital ($p =<0.001$). Institutionalisation was most likely to occur for those who were malnourished, however it must be noted that institutionalisation was rare (n=23) and thus the cell count assumption of the chi-square test was broken.

Discussion

These findings indicate that malnutrition is common in older adults on admission to acute hospitals, particularly among females, older adults, widows/divorcees, those living in the community with others, those admitted acutely, and those under the care of a geriatric team. Dementia, frailty, medical comorbidities and functional dependency were identified as risk factors, and associated outcomes include an increased LOS, in-hospital mortality, and institutionalisation.

Table 4
Multivariate Logistic Regression on Nutritional Status

		Odds Ratio	95% CI	P value
Malnourished[a]				
Intercept				0.919
CIRS-G		1.21	1.08, 1.36	0.001
Barthel Score		0.76	0.67, 0.87	<0.001
Dementia[b]		7.33	1.59, 33.78	0.01
Share-FI	Pre-frail[c]	0.76	0.14, 4.19	0.756
	Frail[c]	7.52	1.75, 32.25	0.007
At-risk[a]				
Intercept				0.652
CIRS-G		1.12	1.03, 1.22	0.007
Barthel Score		0.89	0.80, 0.99	0.045
Dementia[b]		9	2.45, 33.12	0.001
Share-FI	Pre-frail[c]	0.72	0.32, 1.65	0.441
	Frail[c]	2.62	1.15, 5.96	0.022

'a' reference category = normal nutritional status, 'b' reference category = no dementia, 'c' reference category = non-frail

The prevalence of malnutrition (18%) is in line with some previous findings, ranging from 13-32% (14, 28-30), but not others: Chen et al. (13) reported that just 4% of hospitalised older adults are malnourished, however people with MMSE scores ≤20 were excluded and only 114 orthopaedic/cardiac patients were included from one hospital. Similarly, a cross-sectional study (N=769) reported that just 7% were malnourished on admission (31), however PwD were not identifiable, and the exclusion criteria were unclear. Conversely, a retrospective pooled analysis reported that almost 40% of hospitalised older adults are malnourished, however the authors highlighted the significant study heterogeneity (15). A Norwegian study (N=508) found that 45% of older patients were 'nutritionally at-risk' (8), combining those who are malnourished and those who are at-risk. This finding is substantially lower than the combination of the malnourished and at-risk categories in this study (63%). This is likely partially attributable to (i) the use of a tool not developed for use with older adults, and (ii) the omission of PwD.

While there has been no Irish study to date estimating malnutrition prevalence in this population, findings from a case-note review (n=660) across 35 hospitals in Ireland indicate that nutritional status is poorly assessed in PwD (median age 83), with one-quarter of patients not receiving a nutrition screen or assessment during their admission (7). Given that malnutrition is particularly common in dementia (32), it is likely that the performance of nutritional assessments is at least as poor in hospitalised older adults generally in Ireland.

Our findings corroborate previous findings regarding the relationship between malnutrition and age, but not educational or marital status (13). It is possible that an extraneous variable, such as socio-economic status (SES) or income, has a role in the relationship between education and malnutrition, and marital status and malnutrition, but we did not explore SES in this study. The finding that those living with others, or in NHs, were more likely to be malnourished than those living alone seemed counter-intuitive initially; it was anticipated that an increased level of support might positively affect nutritional status. However, it is also possible that those living alone have a superior nutritional status than those who require assistance from others, because they are functionally better able to live alone (the present multivariate results support this).

Further analysis indicated that clinical factors including dementia, frailty, greater medical morbidities, and greater functional dependency independently predicted malnutrition in older adults on admission to hospital. A recent systematic review of longitudinal studies investigating risk factors for malnutrition in older adults generally (not just hospital populations), also found that frailty, dementia, and decline in physical function were all significant risk factors (33). Functional dependency has previously been found to predict poor nutritional status in hospitalised older adults in particular (13). This is important, in that it is often possible to intervene and offset impairments in functioning for this population. Other studies have reported that cognitive impairment and medical comorbidities are independent predictors of malnutrition at

Table 5
Outcomes Associated with Nutritional Status

Outcomes		Normal n (%) n=222	At-Risk n (%) n=274	Malnourished n (%) n=106	Statistic	df	P-value
LOS Median [Q1–Q3][a]		4[4]	5.5[7]	7[8]	H = 22.89	2	<0.001
	Mean Rank	261.06	313.24	353.51			
Died in hospital	Yes	2(0.9)	9 (3.3)	12(11.4)	χ^2 = 21.87	2	<0.001
	No	220(99.1)	265(96.7)	93(88.6)			
Institutionalisation	Yes	3(1.4)	9(3.6)	11(14.3)	χ^2 = 23.85	2	<0.001
	No	215(98.6)	240(96.4)	66(85.7)			

a = interquartile range

hospital admission (13, 16). The findings of the present study regarding dementia fit with other findings that those with normal cognition have a higher food intake than those with cognitive impairment (34), and that those with moderate-severe dementia have a significantly lower intake than those in the mild stages (35). Regarding medical comorbidities; while having multiple chronic conditions is non-modifiable, it is useful for healthcare professionals to be aware that this does increase the risk of malnutrition in this population. The predictive model might have been improved by the inclusion of other clinical variables on admission including for example, serum albumin, inflammatory markers, or grip strength; however this information was not recorded in the present study.

In contrast with the present findings, a Taiwanese study (13) found that female sex does independently predict malnutrition in hospitalised older adults; however this small-scale study did not account for dementia. It is possible that when dementia is accounted for, as in the present study, sex may lose statistical significance, due the significant relationship between female sex and dementia (36). Similarly, frailty has been found to be associated with female sex in older adults (37), which is unsurprising due to a number of physiological sex differences (e.g. females have lower average lean mass and strength) (38). This study also supports the findings of previous studies that have found that an increased LOS (5, 31), increased in-hospital mortality (5) and new admission to a NH/long-term care (5, 39) are statistically associated with malnutrition in hospitalized older adults.

Previously, studies in this area have focused on small, narrowly-defined specialties within hospitals (13, 14, 16), collected data retrospectively (16), sampled in just one hospital (8, 31) and/or have collected data on less than 200 inpatients (13, 28, 29). Furthermore, PwD have been largely excluded in this area (8, 13) or are not identifiable within the data (14, 15, 29-31). This cohort study had a sizeable sample compared to preceding research, and is the largest European multicentre prospective cohort study to include all acute and elective admissions across multiple hospitals, as well as the only Irish study to date to investigate the prevalence, correlates and short-term outcomes of malnutrition in older adults on admission to hospital. We not only included those with a pre-existing dementia diagnosis, but also comprehensively assessed for and clinically-diagnosed dementia at the point of hospital admission. This is a substantial strength; many studies including hospitalised PwD rely on diagnoses recorded in case-notes, however this practice has been shown to grossly under-estimate dementia (40).

This study might be limited by its use of the MNASF-R; however, it is likely that the use of a shorter-form tool such as the MNASF-R would make the routine nutritional screening of all older adults in hospitals more feasible, given the busy and demanding context, and the associated time constraints involved in care provision for this population. This particular tool has been validated against the longer form MNA for older adults in hospitals, and across healthcare settings, demonstrating strong psychometric properties (19). Compared to the Malnutrition Universal Screening Tool (MUST), the short form MNA has been found to more accurately detect malnutrition in frail older hospital patients (41, 42) and better predicts mortality risk (42). The tool has also demonstrated high predictive validity relating to mortality, LOS and hospital readmission rates (5) as well as to the risk of falls (43). A recent study investigating the accuracy of four modified shorter form versions of the MNA, concluded that the short form version employed in the present study, utilising BMI, most accurately detected malnutrition in hospitalised older adults with diabetes (44). Future research should explore how nutritional screening, assessment and care practices can feasibly be improved for older adults in acute hospitals in the context of the healthcare system, with a view to better detection and management of nutritional care needs in this population.

In conclusion, this study provides multicentre data on the prevalence and associations of malnutrition in hospitalised older adults for the first time in Ireland. The findings support the prioritisation of nutritional screening in clinical practice and public health policy, for all patients ≥70 on admission, and in particular for PwD, increased functional dependency and/or multi-morbidity, and those who are frail.

Conflict of Interest: The authors have no conflicts of interest to report.

Authors Contributions: EOS analysed the data and drafted the manuscript. EM, AB and VB collected the data. StT coordinated the study. SuT conceived of and coordinated the study, and reviewed the final manuscript.

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