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ORIGINAL ARTICLE

Malnutrition, functional ability and mortality among older people aged ⩾60 years: a 7-year longitudinal study

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BACKGROUND/OBJECTIVES: This study aimed to assess the association between risk of malnutrition and 7-year mortality, controlling for functional ability, socio-demographics, lifestyle behavior and diseases, and investigate the interaction between risk of malnutrition and functional ability on the risk of mortality.

SUBJECTS/METHODS: A longitudinal study on home-living and special-housing residents aged ⩾60 years was conducted. Of 2312 randomly invited participants, 1402 responded and 1203 provided information on both nutritional status and functional ability. The risk of malnutrition was estimated by the occurrence of at least one anthropometric measure (BMI, MAC and CC) below cut-off in addition to the presence of at least one subjective measure (decreased food intake, weight loss and eating difficulty).

RESULTS: At baseline, 8.6% of subjects were at risk of malnutrition and during the 7-year follow-up 34.6% subjects died. The risk of malnutrition was independently associated with 7-year mortality (hazard ratio (HR) 1.84, 95% confidence interval (CI) 1.28–2.65). Additional independent predictors were dementia (HR 2.76, 95% CI 1.85–4.10), activity of daily living (ADL) dependence (HR 2.08, 95% CI 1.62–2.67), heart disease (HR 1.44, 95% CI 1.16–1.78), diabetes (HR 1.41, 95% CI 1.03–1.93) and older age (HR 1.09, 95% CI 1.07–1.10). Moreover, the risk of malnutrition and ADL dependence in combination predicted the poorest survival rate (18.7%, $P < 0.001$).

CONCLUSIONS: The risk of malnutrition significantly increases the risk of mortality in older people. Moreover, risk of malnutrition and ADL dependence together explain a significantly poorer survival rate; however, the importance of this interaction decreased in the multivariable model and risk of malnutrition and ADL dependence independently explained a significant risk of mortality.

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INTRODUCTION

Longevity is one of the ultimate goals of health care. The demographic transition has increased the interest to determine potentially modifiable risk factors responsible for pre-term mortality among old people, from both clinical and epidemiological perspectives.[1] In contrast to non-modifiable factors, such as age and gender, nutrition could be a factor that can be modified to improve life expectancy by optimizing health and preserving functional capacity.

The term 'malnutrition' is used interchangeably with 'undernutrition' and represents a condition characterized by a deficiency of energy and nutrients.[2] In older people, age-associated factors such as sensory losses of taste and smell, decreased ability to chew, digestion problems[3] and decline in muscle mass increase the risk of malnutrition.[4] Some studies suggest covariance of malnutrition and mortality in older people[1,5] whereas others contradict.[6,7] A systematic review stated that the association between malnutrition and mortality is more pronounced in hospitals compared with community dwelling.[8] This evidence emphasizes the need for nutritional risk screening at the community level, as after hospitalization the effects of malnutrition are irreversible.[1] However, the association of malnutrition with mortality is mostly studied in hospitals or among nursing home residents. This factor limits the generalizability of findings at the population level among older people, as the majority of them are living in ordinary homes.[5] Therefore, more studies are needed to investigate the association between risk of malnutrition and mortality by involving populations from both special housing (receiving services around the clock, for example, nursing homes) and from ordinary homes in the same study.

In older people, malnutrition and functional ability are interrelated concepts. Declined functional ability can lead to malnutrition[9] because of limited access to grocery stores and reduced ability to cook and eat or vice versa.[10] Moreover, declined functional ability has been recognized as an independent risk factor of pre-term mortality in older people.[11] Thus, it is relevant and important to explore the interaction between risk of malnutrition and functional ability when investigating the risk of pre-term mortality among older people.

A systematic review highlighted the lack of research on the independent association between risk of malnutrition and mortality,[8] and emphasized the need of further studies to investigate the association between risk of malnutrition and mortality, controlling for influencing confounders common in old age. Frailty in terms of unintentional weight loss, weakness and low physical activity[12] is common in old age, and increases the risk of pre-term mortality. Thus, when investigating the true association between risk of malnutrition and mortality in older people, it is necessary to consider functional ability, diseases[13] and physical activity.

Thus, this study aimed to explore the association of risk of malnutrition with 7-year mortality among older people aged ⩾60 years after controlling for functional ability, age, gender, living arrangement, economic status, smoking, physical activity and

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diseases. The secondary aim was to investigate the interaction between risk of malnutrition and functional ability on mortality risk.

MATERIALS AND METHODS

Study design and population

A longitudinal study design was used. The study population consisted of 1203 participants aged 60–96 years including both ordinary home-living and special-housing residents who were participants of the baseline survey (2001–2003) of an ongoing longitudinal study: The Swedish National Study of Aging and Care-Blekinge (SNAC-B). SNAC-B is one of the four research centers of SNAC, including one municipality in south-east Sweden with ~60 600 inhabitants. The details of SNAC have been described elsewhere.[14] A national population register was used for the recruitment of the study population, and subjects were randomly selected for age cohorts 60, 66, 72 and 78 years, and the entire population for age cohorts 81, 84, 87, 90, 93 and 96 years. Participants were invited through email and phone calls, and reasons for non-participation were registered.[15] Of 2312 randomly invited participants, 1402 responded and 1203 provided information on both nutritional status and functional ability at baseline. These participants were then followed up for 7 years. The data collection team consisted of both nurses and physicians. The study was conducted in accordance with the Helsinki declaration, and both verbal and written informed consent was obtained. The SNAC-B was approved by the ethics committee of Lund University (LU 605-00, LU 744-00).

Measurements and instruments

The information on age, gender, living arrangement, diseases (heart diseases, diabetes, cancer, dementia, and depression) and smoking was obtained through a single-item self-administered questionnaire. For subjects with dementia and depression proxy measures were used. Economic status was estimated by a two-item questionnaire: 'having sufficient financial resources to manage 14 000 SEK (Swedish Krona) in a week for emergency expenditures' and 'have had insufficient financial resources to manage daily expenditure during the last 12 months'. Physical activity was measured by two questions: 'How often have you been involved in light intensity physical activity (e.g., walking, short bicycle tours, light gymnastics or similar activities) during the last 12 months?' and 'How often have you been involved in strenuous physical activity (e.g., jogging, long and high intensity walking, intense gymnastics, skating, skiing, or similar activities) during the last 12 months?'.[16]

Functional ability was estimated by activities of daily living (ADL; that is, bathing, dressing, toileting, transferring, continence and feeding)[17] and by instrumental ADL (IADL; that is, cleaning, transportation, shopping and cooking).[18] The score '1' was given for dependency for each activity, ranging from 0 to 6 for ADL and 0 to 4 for IADL. For grading the level of dependence, score '0' represents independence in all 6 activities for ADL and 4 activities for IADL, whereas scores '6' and '4' represent total dependence in ADL and IADL, respectively. Thus, functional dependence was defined as ADL $\geqslant 1$ and IADL $\geqslant 1$.[19]

Nutritional status was assessed by three anthropometric measurements —body mass index (BMI), mid-arm circumference (MAC) and calf circumference (CC)—and three subjective measures—'decreased food intake over last 3 months', 'weight loss during the last 3 months' and 'eating ability', which refers to the ability to eat independently.[20] Anthropometric measurements were taken by the research staff during a medical examination. BMI (kg/m^2) was calculated from weight and height. MAC and CC were measured with a flexible tape to the nearest 0.1 cm of the left arm and leg, respectively. In this study, cut-offs of anthropometric measurements were defined by the 15th percentile. The criterion used to define the risk of malnutrition was the occurrence of at least one anthropometric measurement below cut-off (that is, BMI < 23 kg/m^2, MAC $\leqslant 25.5$ cm and CC $\leqslant 32$ cm) in addition to the presence of at least one subjective measure (that is, declined food intake, weight loss and need of help when eating).[20] The information on mortality during the 7-year follow-up was collected from the population mortality register.

Statistical analysis

For descriptive statistics, continuous variables are presented as median and interquartile range (IQR), and categorical variables are given as percentages (Table 1). The data were not normally distributed; therefore, for the comparison between groups (survivors and deceased) the χ^2 test was used for categorical data, and the Mann–Whitney's *U*-test was used for ordinal and interval data. For analysis, ADL and IADL were used as dichotomous variables because of lower sample size for each grade of dependence and for better understanding of graphical presentation. Survival time was calculated from the date of the baseline interview to the date of death during the 7-year follow-up. Univariate Cox proportional hazard analysis was performed to investigate the possible predictors of mortality.[21] To explore the independent risk factors of mortality, variables that exhibited a significant association in a univariate analysis (nutritional status, ADL, IADL, age, physical activity, housing, emergency expenditure, heart diseases, diabetes and dementia) were entered simultaneously in the first step of a multivariable Cox regression model. In this study, multiple confounders were included. Therefore, to make the model more robust the likelihood ratio (LR) significance test was used for goodness-of-fit model. LR accounts for the likelihood of variables to explain satisfactorily the risk of outcomes, and whether the addition or removal of more variables makes a significant difference.[22] Thus, variables with the lowest χ^2 in the baseline model were excluded stepwise, and the model was re-estimated. At the last step, the interaction term between nutritional status and ADL was included in the Cox regression model. The results are presented as a hazard ratio (HR) with 95% confidence interval (CI). A *P*-value of < 0.05 was considered significant.

To estimate the impact of nutritional status and ADL (separately and in combination) on survival, a Kaplan–Meier survival analysis was executed. For functional ability, Kaplan–Meier was performed only for ADL, as IADL did not exhibit an independent association in the Cox regression model. The difference between groups was assessed by the log-rank test.[23] Survival curves were truncated at 5 years as the frequency of participants at risk after that time was small. Analyzes were conducted using the statistical software SPSS version 21 (SPSS Inc., Chicago, IL, USA), for Windows and STATA version 13.1 (Stata Corp LP, College Station, TX, USA).

RESULTS

In this study, 1203 subjects with a median age of 78.0 (IQR, 66.0–84.0) years participated at baseline and 56.5% of them were female (Table 1). The median follow-up time was 6 years (IQR, 4.6–6.2 years, range 0.03–6.99 years). During the 7-year follow-up, 416 subjects (34.6%) died. Compared with survivors, the subjects in the deceased group were significantly older (median age 84.0 vs 72.0 years, $P < 0.001$), at higher risk of malnutrition (19.5 vs 2.8%, $P < 0.001$) and dependent in ADL (39.9 vs 8.3%, $P < 0.001$) and IADL (67.3 vs 37.4%, $P < 0.001$). Moreover, subjects in the deceased group were more likely to be a resident of special housing (11.7 vs 2.9%, $P < 0.001$), not involved in light (48.6 vs 29.3%, $P < 0.001$) and strenuous physical activity (83.3 vs 68.4%, $P < 0.001$), not capable of managing emergency expenditures (23.3 vs 15.8%, $P = 0.003$) and experiencing heart disease (68.5 vs 47.0%, $P < 0.001$), diabetes (11.6 vs 7.4%, $P = 0.015$) and dementia (7.8 vs 0.4%, $P < 0.001$).

The Kaplan–Meier survival curve showed that the subjects at risk of malnutrition had lower survival rate (37.8%) compared with the well-nourished ones (76.6%, $P < 0.001$; Figure 1). The median survival time for those with risk of malnutrition was 3.7 years (IQR, 1.8–6.0), and 6.8 years (IQR, 5.3–6.9) for the well-nourished individuals. A similar trend was found for those with ADL dependence displaying a significant ($P < 0.001$) lower survival rate (38.0%) than those without dependency (81.7%; Figure 2). The median survival time was 3.7 years (IQR, 2.0–6.8) for the ADL dependence group and 6.8 years (IQR, 6.3–6.9) for the reference group. The comparison between combinations of nutritional status and ADL showed significant differences in survival rate ($P < 0.001$). Risk of malnutrition and ADL dependence together explained the lowest survival rate and median survival time (18.7%, median 2.2 years, respectively), compared with the combinations of risk of malnutrition and ADL independence (54.5%, median 5.2 years), well nourishment and ADL dependence (43.1%, median 4.3 years), and well nourishment and ADL independence (83.4%, median 6.8 years), respectively (Figure 3).

In the univariate Cox regression model, the HR for mortality was 3.89 (95% CI 3.04–4.98) in the group at risk of malnutrition, whereas this HR decreased to 1.84 (95% CI 1.28–2.65) in the

Table 1. Baseline characteristics of the total sample ($n = 1203$) and stratified by survivors and deceased

Variables	*Baseline* (n = *1203*)	*Survivors* (n = *787*)	*Deceased* (n = *416*)	P-*value*
Age median (IQR)	78.0 (66.0–84.0)	72.0 (66.0–81.0)	84.0 (81.0–87.0)	< 0.001
Female (%)	56.5	57.4	54.8	0.382
Special housing (%)	5.9	2.9	11.7	< 0.001
Emergency expenditure (yes, %)	81.9	84.2	76.7	0.003
Daily expenditure (yes, %)	5.7	5.0	7.1	0.165
Smoker (%)	10.3	10.9	8.9	0.548
Ex-smoker	35.7	35.4	36.3	
Non-smoker	54.0	53.7	54.9	
Light physical activity (active, %)	65.0	70.7	51.4	< 0.001
Strenuous physical activity (active, %)	27.3	31.6	16.7	< 0.001
Functional ability				
ADL (0–6) median (IQR)	0.0 (0.0–0.0)	0.0 (0.0–0.0)	0.0 (0.0–1.0)	< 0.001
IADL (0–4) median (IQR)	0.0 (0.0–2.0)	0.0 (0.0–1.0)	2.0 (0.0–4.0)	< 0.001
Dependent in ADL (⩾1%)	19.2	8.3	39.9	< 0.001
Dependent in IADL (⩾1%)	47.7	37.4	67.3	< 0.001
Diseases (yes, %)				
Heart disease	54.4	47.0	68.5	< 0.001
Diabetes	8.8	7.4	11.6	0.015
Cancer	13.6	12.3	16.0	0.076
Dementia	2.9	0.4	7.8	< 0.001
Depression	12.8	11.9	14.4	0.229
Nutritional status[a]				< 0.001
Well-nourished (%)	91.4	97.2	80.5	
Risk of malnutrition (%)	8.6	2.8	19.5	
BMI median (IQR)	26.8 (24.3–29.4)	27.0 (24.6–29.6)	26.0 (23.0–28.9)	< 0.001
BMI < 23 kg/m^2 (%)	15.0	11.6	23.5	< 0.001
BMI ⩾ 23 kg/m^2 (%)	85.0	88.4	76.5	
MAC median (IQR)	29.0 (27.0–31.0)	29.2 (27.5–32.0)	28.0 (25.0–30.0)	< 0.001
MAC ⩽ 25.5 cm (%)	15.0	7.9	28.6	< 0.001
MAC > 25.5 cm (%)	85.0	92.1	71.4	
CC median (IQR)	36.0 (33.2–38.0)	36.5 (34.0–38.5)	34.5 (32.0–37.0)	< 0.001
CC ⩽ 32 cm (%)	16.6	9.7	29.9	< 0.001
CC > 32 cm (%)	83.4	90.3	70.1	
Decline in food intake (%)				< 0.001
Yes, significantly	1.6	0.9	2.9	
Yes, slightly	9.1	5.1	16.6	
No	89.4	94.0	80.5	
Weight loss in the last 3 months (%)				< 0.001
Yes (> 3 kg)	3.1	2.3	4.6	
Do not know	2.1	0.8	4.6	
Yes (> 1 to < 3 kg)	9.6	7.9	12.7	
No	85.3	89.1	78.1	
Eating ability (%)				< 0.001
Need much help	0.9	0.0	2.6	
Need little help	2.7	0.9	6.3	
No help	96.3	99.1	91.1	

Abbreviations: ADL, activities of daily living; BMI, body mass index; CC, calf circumference; IADL, instrumental ADL; IQR, interquartile range; MAC, mid-arm circumference. The internal dropouts were ⩽ 10.6%, except for variable physical activity—that is, 20.6% for light and 27.1% for strenuous physical activity. The χ^2 test was performed for nominal data and the Mann–Whitney's *U*-test for the ordinal and interval data. The *P*-value < 0.05 was used to test significance. [a]Risk of malnutrition is defined as the occurrence of at least one anthropometric measure below the cut-off, in addition to the presence of one subjective measure—namely, declined food intake, weight loss and/or needing help in eating.

adjusted multivariate model (Table 2). Moreover, dementia (HR 2.76, 95% CI 1.85–4.10), ADL dependence (HR 2.08, 95% CI 1.62–2.67), heart disease (HR 1.44, 95% CI 1.16–1.78), diabetes (HR 1.41, 95% CI 1.03–1.93) and older age (HR 1.09, 95% CI 1.07–1.10) were significantly associated with mortality in the adjusted multivariate Cox regression model (Table 2). The interaction between nutritional status and ADL that was significant in the univariate model was no longer significant in the multivariate model (HR 0.96, 95% CI 0.57–1.59).

DISCUSSION

In this study, risk of malnutrition was independently associated with a 1.84 times higher risk of mortality within 7 years compared with well nourishment (3.7 vs 6.8 years, respectively). Additional independent predictors of mortality were dementia, ADL dependence, heart disease, diabetes and older age. Moreover, well nourishment and ADL independence showed a higher survival rate (83.4%) together than well nourishment (76.6%) and ADL independence (80.8%) did separately. However, in the multivariate model the importance of interaction between nutritional status and ADL decreased and risk of malnutrition, and ADL dependence independently explained a significant risk of mortality.

At baseline, 8.6% of subjects were at risk of malnutrition. This risk rate is consistent with the findings of another Swedish study on ordinary home-living individuals (⩾65 years) using mini-nutritional assessment as a screening tool and baseline data collected during approximately the same years (1999–2001) as the

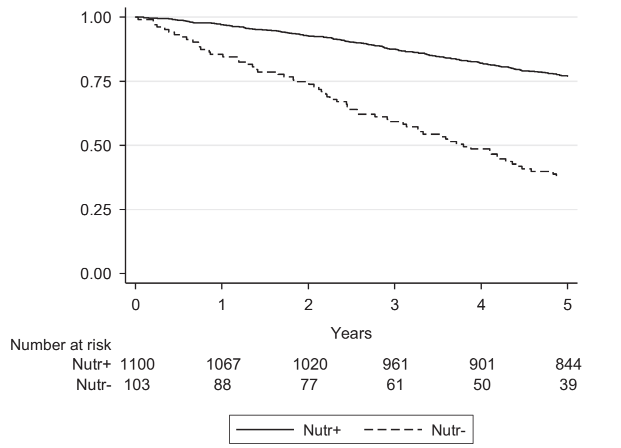

Figure 1. Kaplan–Meier survival curves according to nutritional status. Survival differed significantly (log-rank test $P<0.001$) between well nourishment (Nutr+) and risk of malnutrition (Nutr −).

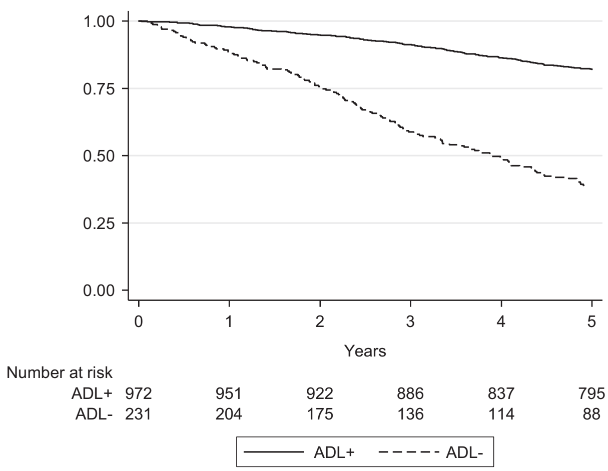

Figure 2. Kaplan–Meier survival curve according to ADL status. Survival differed significantly (log-rank test $P<0.001$) between independency (ADL+) and dependency (ADL −) in ADL.

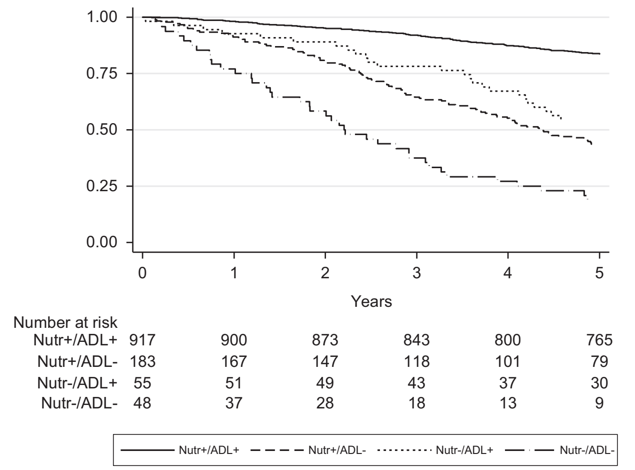

Figure 3. Kaplan–Meier survival curves according to various combinations of nutritional and ADL status in which Nutr+ represents well nourishment and ADL+ represents ADL independence. Survival differed significantly between the combinations (log-rank test $P<0.001$).

present study.[24] However, this risk rate is lower than that reported by other studies conducted among older Swedish people—that is, 41% in those receiving home-care services,[25] 27% in special-housing residents[26] and 65% in hospital patients.[27] It is rational to assume that ordinary home-living older people are at a relatively lower risk of malnutrition compared with special-housing and hospital patients. It is not the place of dwelling that increases the risk of malnutrition, but declined functional ability and poor health, both being more common among special-housing than among home-living residents.[25] In this study, the lower risk rate of malnutrition can be explained as the majority of the participants were home living (94.1%). Moreover, subjects at risk of malnutrition were more likely to be residents of special housing compared with those living at home (17.5 vs 4.8%, $P<0.001$), and only 5.9% of the total study sample were special-housing residents. Furthermore, diverse nutrition screening tools,[28] population settings and age[29] explain variations in the findings.

Although a lower risk of malnutrition was observed in this study, the hazard of mortality over 7 years associated with risk of malnutrition (HR 1.84, 95% CI 1.28 – 2.65) was comparable to that of the older people receiving home-care services (HR 1.89, 95% CI 1.18–3.01),[25] special-housing residents (HR 1.86, 95% CI 1.32–2.63)[9] and hospitalized patients (HR 1.56, 95% CI 1.18–2.07).[27] In the present study, risk of malnutrition had a similar risk of mortality as diabetes and heart disease. Thus, the risk of malnutrition is a life-threatening health problem in older people, and this emphasizes the importance of nutritional screening at the population level, identification of causes, and development of solutions. The recommendations to reduce risk of malnutrition include food supplementation and adherence to nutrition guidelines. However, in older people, ADL and IADL independence could be a prerequisite to these recommendations.

The findings of this study, that ADL dependence has an independent association with mortality, support the evidence that ADL independence is crucial for survival in old age.[11] Nutritional risk assessment includes low anthropometric measures, weight loss and decline in food intake, which are also ADL dependence risk factors; therefore, a correlation between malnutrition and ADL is probable.[25] In the present study, a correlation was observed between nutrition and ADL ($r_s=0.226$, $P=0.01$). This indicates that persons with ADL dependence carry a risk of malnutrition and vice versa. In this study, participants who had both a risk of malnutrition and ADL dependence ($n=48$) showed the lowest survival rate (18.7%), and this survival rate was lower than the risk of malnutrition and ADL dependence when considered separately (37.8 and 35.0%, respectively). This evidence suggests that ADL dependence makes the consequences of malnutrition more problematic. For instance, people with ADL dependence need help to perform daily activities; therefore, they are less active and may spend most of their time sitting still. Declined activity level and age are associated with lower basal metabolic rate, resulting in poor appetite.[30] Accordingly, inadequate dietary intake worsens nutritional status and accelerates the process of weight loss and muscle mass depletion,[31] leading to mortality. This process underscores the importance of delaying the onset of ADL dependence in older age to improve the association between nutrition and survival.

Another notable finding of this study, that dementia is an independent predictor of mortality, is consistent with the findings of other studies among older people.[32] The association of dementia with mortality can be direct or indirect, as dementia increases risk of malnutrition and ADL dependence.[10] However, one review-based study stated that inadequacy of certain nutrients (vitamins B_{12}, B_6, folate, antioxidants C, E and β-carotene) and/or nutritional disorders (hypercholesterolemia, hypertriglyceridemia, hypertension and diabetes) exist long before dementia occurs.[33] Thus, it can be

Table 2. Predictors of mortality according to Cox proportional hazard regression models

Variables	*n*	*Univariate model*[a]			*Multivariate model* (n = *1184*)[b]		
		HR	*95% CI*	P-*value*	*HR*	*95% CI*	P-*value*
Risk of malnutrition	1203	3.89	3.04–4.98	< 0.001	1.84	1.28–2.65	0.001
ADL dependency	1203	4.26	3.49–5.20	< 0.001	2.08	1.62–2.67	< 0.001
IADL dependency	1203	2.71	2.21–3.33	< 0.001	—	—	—
Age	1203	1.11	1.09–1.12	< 0.001	1.09	1.07–1.10	< 0.001
Physical activity							
Light (sedentary)	955	2.02	1.60–2.56	< 0.001	—	—	—
Strenuous (sedentary)	876	2.00	1.43–2.79	< 0.001	—	—	—
Special housing	1136	2.94	2.15–4.01	< 0.001	—	—	—
Emergency expenditure (yes)	1087	1.37	1.06–1.77	0.014	—	—	—
Diseases							
Heart (yes)	1203	2.02	1.64–2.48	< 0.001	1.44	1.16–1.78	0.001
Diabetes (yes)	1199	1.48	1.10–2.00	0.010	1.41	1.03–1.93	0.029
Dementia (yes)	1188	7.36	5.10–10.61	< 0.001	2.76	1.85–4.10	< 0.001
Nutrition*ADL	1203	5.96	4.33–8.22	< 0.001	0.96	0.57–1.59	0.875

Abbreviations: ADL, activities of daily living; CI, confidence interval; HR, hazard ratio; IADL, instrumental ADL. In Cox regression (univariate and multivariate model), well nourishment, independence in ADL and IADL, lower age, active in light and strenuous physical activity, home living, being capable of managing emergency expenditure and not having heart disease, diabetes and dementia were used as reference categories. [a]Only significant variables are presented. [b]Likelihood ratio was 470.57 ($P < 0.001$).

assumed that inadequate nutrition increases the risk of dementia, and the occurrence of dementia exacerbates malnutrition[33] and ADL dependence, leading to mortality. Therefore, longitudinal studies are needed to assess the effects of nutrition on the association between dementia and mortality.

The strengths of this study include a prospective design, a large sample size and the inclusion of several confounders relevant to older age that may influence the association between risk of malnutrition and mortality. Moreover, the study population included both ordinary home-living and special-housing residents; therefore, the results can be generalized to the general older population. Furthermore, the interaction between nutrition and ADL was assessed for prediction of mortality, as functional decline is a common phenomenon of ageing.

Limitations might include self-reported weight loss that may introduce a bias due to memory impairments common in old age and lead to misclassification of nutritional risk. However, an index was used for nutritional risk assessment by including two more subjective assessments and anthropometric measures. Also, the proportion of special-housing residents in this study coincided with the proportion at the national level in Sweden—that is, 6%—[34] but the study participants were generally healthier than non-participants. Approximately 10% of the invited subjects refused to participate because of poor health; therefore, the rate of ADL dependence and risk of malnutrition might be under-represented.

In conclusion, this study showed that risk of malnutrition independently predicts 7-year mortality among older people aged ⩾60 years, and risk of malnutrition exhibited a similar risk of mortality as heart disease and diabetes. This evidence underscores the importance of nutritional screening, identification and modification of risk factors of malnutrition both in special-housing and in ordinary home-living residents. Dementia and ADL dependence were additional independent predictors of mortality. Moreover, the risk of malnutrition and ADL dependence combined displayed the poorest survival rate: almost two times lower than the risk of malnutrition and ADL dependence did separately. Furthermore, malnutrition and ADL are interrelated concepts, and the presence of one condition increases the risk of the other. Thus, it is important to consider both conditions to promote the survival rate in older people.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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