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PREVALENCE AND ASSOCIATION OF UNDERNUTRITION WITH QUALITY OF LIFE AMONG SWEDISH PEOPLE AGED 60 YEARS AND ABOVE: RESULTS OF THE SNAC-B STUDY

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Abstract: *Objectives:* This study aimed to assess the prevalence of undernutrition among elderly and to investigate the association of risk of undernutrition with health-related quality of life and life satisfaction controlling for age, gender, marital status, economic status, housing arrangement, education level, functional ability, and diseases. *Design:* A cross-sectional study design was used for this study. The baseline data (2001-2003) of "The Swedish National Study of Aging and Care-Blekinge (SNAC-B)" was used. *Setting:* This population-based study focused on both home-living and special-housing residents. Participants: The participants (n=1402) were randomly selected and included both males and females 60-96 years of age residing in a municipality of south-east Sweden. *Measurements:* The risk of undernutrition was estimated by the occurrence of at least one anthropometric measure (body mass index, mid-arm circumference, and calf circumference) below cut-off, in addition to the presence of at least one subjective measure (declined food intake, weight loss, and eating difficulty). The dependent variables, health-related quality of life and life satisfaction, were measured by the validated short form health survey (SF-12) and Liang's life satisfactions index A (LSIA), respectively. *Results:* According to the criterion, 8.5% of the participants were at risk of undernutrition, and subjects at nutritional risk were significantly older, female, unmarried/widowed/divorced, residing in special housing, and functionally impaired. The risk of undernutrition was significantly associated with poor health-related quality of life, both in the physical (OR 2.31, 95% CI 1.18-4.52) and mental (OR 2.34, 95% CI 1.22-4.47) dimensions. However, no significant association was observed between nutritional status and life satisfaction (OR 1.30, 95% CI 0.70-2.40). *Conclusion:* The risk of undernutrition significantly increases the risk of poor physical and mental health-related quality of life but has negligible impact on life satisfaction. This study also highlights the importance of functional ability both for the prevention of undernutrition and promotion of quality of life. However, more studies are needed to validate the tool used here for undernutrition risk assessment before it can be used in clinical or population settings.

Key words: Undernutrition, health-related quality of life, life satisfaction, elderly;

Introduction

The proportion of elderly is increasing worldwide, and this trend is also congruent in Sweden. In 2011, 18% of Sweden's population was 65 years of age or older, and it is projected that one in every five Swedes will be over the age of 65 by 2030 (1). Longevity is desirable, but it does not necessarily mean good quality of life (2), because people spend more years in poor health in later life. This emphasises that it is more important "to add healthy years than only years" to make life worth living (3). This can be accomplished by identifying and modifying the determinants of quality of life (QoL). Nutrition is one of these potentially modifiable factors, because adequate nutrition can delay the onset of frailty or functional dependency by preserving immunity and muscle mass in the elderly (4).

Undernutrition represents a state of nutrition characterised by a deficiency in energy, protein, and other nutrients (5), but the criteria for defining undernutrition depends on the tool being used (6). The selection of such a tool depends on the population under investigation, as use of anthropometry for nutritional risk screening is more convenient to use in the community compared to medical tests (7). According to Swedish guidelines for clinical nutrition and metabolism (8), occurrence of at least one state, involuntary weight loss, body mass index (BMI) below a certain limit (<20 if ≤69 years and <22 if ≥70 years), and eating difficulties, delineate the risk of undernutrition. However, these guidelines have focused only institutionalised and/or hospitalised patients. The European society for parenteral and enteral nutrition (ESPEN) has recommended three principles to be considered for nutrition screening at the community level: 1.What is the condition now? (e.g., BMI < 18.5 represents undernutrition), 2. Is the condition stable? (e.g., involuntary weight loss over three months), and 3. Will the condition get worse? (e.g., decline in food intake) (9). There are few studies that have used Swedish guidelines for nutrition risk assessment (10), but to the best of our knowledge, there is no study that has integrated the guidelines from both sources by involving samples from community and special housing populations in the same study.

The risk of undernutrition increases with advancement of age (11), because the physiological changes with age, such as eating or digestion problems (12), and limited instrumental

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abilities, such as reduced ability to cook or inadequate access to grocery stores, contribute to inadequate dietary intake (7). The increased risk of undernutrition with aging and demographic changes suggests that undernutrition could be a major public health problem in the future. Studies conducted in different parts of Sweden have reported prevalence of undernutrition, 14.5% in home-living of age 75 and 85 years (13), 27% and 51.6% in hospitalised patients of mean age 69 years and ≥ 70 years, respectively (10, 14), and 27% to 38% among special housing residents (assisted living) of mean age 69 years and ≥ 65 years, respectively (10, 15). These studies have focused on samples from one setting, but the inclusion of samples from both home living and special housing, may better reflect the true population. Moreover, the use of age criteria ≥ 60 years, instead of ≥ 65 years can capture how the transition from working to retirement life influences health (16). Therefore, more studies are needed that involve samples from both settings and include individuals 60 years of age or older.

QoL is a broad concept and refers to subjective well-being, but previous studies that investigated the correlation of nutritional status with QoL (17-19) have used this concept in terms of health-related quality of life (HRQoL). Amarantos et al, (12) in a review-based study, argued that HRQoL is a narrow concept that focuses on physical and mental dimensions of health that may change in relation to disease or functional disability, but some persons express high life satisfaction even with some physiological impairment due to their adaptive potential (20) or vice versa. Therefore, to determine the potential role of nutrition as a determinant of QoL, a holistic view of QoL is needed in terms of physical, mental, and psychological well-being (12, 21), but the studies that tap the psychological construct of QoL in relation to undernutrition are sparse. However, several studies have investigated the association of nutrition and HRQoL, and while some have found that undernutrition is a risk factor of poor HRQoL in the elderly (17, 21, 22), others have found contradictory evidence (19). These inconsistencies regarding the association of nutrition with HRQoL and the limited research on the correlation of nutrition with life satisfaction emphasise the need for more research in this field.

Aim

This study aimed to investigate the prevalence of undernutrition among elderly people between 60 and 96 years of age and to assess the association of risk of undernutrition with HRQoL and life satisfaction controlling for age, gender, marital status, economic conditions, education level, housing arrangement, functional ability, and diseases.

Materials and Methods

Study design and population

A cross-sectional design was used. The study sample consisted of 1402 subjects 60-96 years of age, including both home-living and special-housing residents (individuals receiving 24-hour services/assisted living), who participated in the baseline survey (2001-2003) of an ongoing longitudinal cohort study: The Swedish National Study of Aging and Care-Blekinge (SNAC-B). SNAC-B is one of the four research centres of SNAC and involves one municipality located in south-east part of Sweden with approximately 60,600 inhabitants (23). The details of SNAC are given elsewhere (16). The target population of SNAC-B was randomly selected from the national population register for four age cohorts (60, 66, 72, and 78 years) and the entire population for six age clusters (81, 84, 87, 90, 93, and 96 years) (2). Out of 2312 subjects, 1402 agreed to participate, and the reasons of nonparticipation were registered (23). The data collection team included nurses and physicians. Verbal and written informed consent was obtained for self-administered questionnaires and medical examination, respectively (23). The SNAC-B was approved by the ethics committee of Lund University (LU 605-00, LU 744-00).

Measurements and Instruments

The dependent variable, QoL, was measured as health-related quality of life (HRQoL) and life satisfaction. HRQoL was measured by the short form health survey (SF-12). The physical component summary (PCS-12) of SF-12 includes subjective evaluation of health, difficulty in performing moderate activities, climbing of several flights of stairs, bodily pain, accomplished less due to physical health, and the mental component summary (MCS-12) includes accomplished less, not being careful in daily activities, social extent, energy level, sadness, calm and peaceful (24). The score of each dimension of SF-12 ranges from zero (poorest) to 100 (highest) HRQoL. The Cronbach's alpha (25) for the PCS-12 was 0.86, and for the MCS-12, it was 0.77.

Life satisfaction was measured by Liang's model (26) of life satisfaction index A (LSIA). This model is composed of 11 items to estimate the subjective evaluation of life as a whole, such as happy as younger, more breaks in life, could be happier, best years, boring life, expect pleasant future, interesting things as ever, feeling tired, satisfied, don't want to change past life, and gotten much than expected. The response alternatives were agree, do not agree, and don't know. The score ranges from 0 to 11; a higher value represents high life satisfaction. The Cronbach's alpha (25) of this scale was 0.74.

Independent Variables: In this study, nutritional status was assessed by three anthropometric measurements: body mass index (BMI), mid-arm circumference (MAC), and calf circumference (CC), and three subjective measurements: decrease in food intake over 3 months, weight loss during the last 3 months, and eating ability, which refers to the subject's ability to eat independently or only with help (Table 1). The criterion used to define risk of undernutrition was "the occurrence of at least one anthropometric measure below cut-off, in addition to the presence of one subjective measure, i.e., declined food intake, weight loss, or needed help in eating".

Table 1
Descriptive statistics of total subject population (n=1402) and in relation to nutritional status

Variables	Total population (n=1402)	Risk of Under-nutrition (n=113, 8.5%)	Well-nourished (n=1215, 91.5%)	p-value
Age mean(SD)	76.7(10.2)	84.2(7.2)	75.5(10.0)	<0.001
Gender (%)				
Female	57.9	73.8	56.0	<0.001
Marital status (%)				
Married	52.2	27.0	55.2	<0.001
Unmarried/widowed/divorced	47.8	73.0	44.8	
Housing arrangement (%)				
Regular housing	93.5	84.0	95.3	<0.001
Special housing	6.5	16.0	4.7	
Economic status (%)				
14000 SEK a week for emergency expenditure (Yes)	81.4	75.0	82.4	0.090
Difficulty to pay utility bills during last year (Yes)	6.0	6.8	5.6	0.642
Education (%)				
Primary school left at age 11-12	54.3	55.0	54.1	0.502
Secondary school, left at age 14-16	12.1	18.3	11.8	
High/vocational school left at 18-19	20.9	18.3	20.9	
College or above	12.8	8.3	13.2	
Functional ability (%)				
Excellent/good	68.0	28.3	74.3	<0.001
Mild impairment	13.4	26.5	12.2	
Moderate impairment	6.9	13.3	5.9	
Severe impairment	3.9	6.2	3.4	
Total impairment	7.9	25.7	4.2	
Disease %				
Heart disease (Yes)	54.7	66.4	53.7	0.009
Diabetes (Yes)	9.3	10.6	8.6	0.467
Cancer (Yes)	14.1	17.0	13.4	0.301
Dementia (Yes)	3.6	10.8	2.2	<0.001
Depression (Yes)	13.8	17.0	13.1	0.257
BMI mean (SD)	27.0 (4.1)	22.3(2.8)	27.3 (3.9)	<0.001
BMI < 23 kg/m^2 (%)	15.5	67.1	12.2	<0.001
BMI ≥ 23 kg/m^2 (%)	84.5	32.9	87.8	
MAC mean(SD)	28.9(3.4)	24.9(2.4)	29.3(3.1)	<0.001
MAC ≤ 25.5 cm (%)	15.5	62.5	10.8	<0.001
MAC > 25.5 cm (%)	84.5	37.5	89.2	
CC mean(SD)	35.6(3.5)	31.1(3.0)	36.0(3.2)	<0.001
CC ≤ 32 cm (%)	16.9	69.4	11.7	<0.001
CC > 32 cm (%)	83.1	30.6	88.3	
Decrease in food intake (%)				<0.001
Yes, significant decrease	1.4	4.4	1.2	
Yes, slight decrease	9.1	46.9	5.1	
No	89.5	48.7	93.7	

Table 1 (continued)

Variables	Total population (n=1402)	Risk of Under-nutrition (n=113, 8.5%)	Well-nourished (n=1215, 91.5%)	p-value
Weight loss during last 3	3.1	13.3	2.1	<0.001
months (%) Yes, >3 kg Don't know	2.1	15.0	0.7	
Yes, > 1 kg <3 kg	9.3	39.8	6.4	
No	85.4	31.9	90.7	
Ability to eat (%)				
Need help	1.0	8.8	0.1	<0.001
Need little help	2.8	16.8	1.3	
Eat without help	96.2	74.3	98.6	
PCS-12 mean (SD)	42.4(11.6)	33.8(11.6)	43.2(11.2)	<0.001
MCS-12 mean (SD)	54.3(8.6)	49.4(10.5)	54.6(8.3)	<0.001
LSI mean (SD)	6.1(2.7)	5.1(2.7)	6.2(2.6)	0.002

Note: Chi-squared test was performed for nominal data and Mann-Whitney U test for the ordinal and interval data. The internal dropouts were ≤ 14, except for education, i.e., 33.7%. The p-value < 0.05 was used to test significance..

Anthropometric measurements were taken by the research staff during medical examination. BMI was assessed by measuring weight in kilograms and dividing it by height in meters squared (23). MAC of left arm and CC of left leg was measured by a flexible measuring tape to the nearest 0.1 cm. In this study, the 15^{th} percentile (6, 27) was used to define the cut-offs of anthropometric measurements. Thus, BMI <23 kg/m^2, MAC ≤ 25.5 cm, and CC ≤ 32 cm indicate the risk of undernutrition.

Data on age, gender, marital status, housing arrangement, education, and diseases (heart diseases, diabetes, cancer, dementia and depression) were collected through a single-item self-administered questionnaire. Economic status was assessed by two items, sufficient financial resources to manage 14,000 SEK (Swedish krona) in a week and insufficient financial resources to meet daily needs during last 12 months (Table 1).

Functional ability was measured by using the rating scale of activity of daily living (ADL), taken from the Older Americans' Resources and Services (OARS) questionnaire (28). Instrumental dimension of ADL (IADL) assesses the ability to go for shopping, take medications, prepare meals, do household work, handle money, use transport and phone, and the physical dimension of ADL (PADL) assesses the ability to eat, dress, take care of personal appearance, walk, get in and out of bed, take a bath by yourself, and get to the toilet in time (23). The response alternatives were without help, with help and unable to do. An ordinal scale was constructed in accordance to Fillenbaum's algorithm including all 14 items: excellent ADL, mild impairment, moderate impairment, severe impairment, and total impairment (23). The Cronbach's alpha (25) of this scale was 0.94 (29).

Statistical Analysis

For descriptive statistics of continuous variables, mean and standard deviation (SD) were used, and for categorical variables, percentage and frequency measures were used (Table 1). Non-parametric tests were performed because the data were not normally distributed. For the comparison between groups, a Chi-squared test was used for the nominal data and a Mann-Whitney U test was used for the ordinal and interval data. To test significance, a p-value < 0.05 was used. For analyses, the response alternatives of three subjective measurements, i.e., decline in food intake, weight loss, and eating ability were reduced to two categories due to very small percentages in extreme categories (Table 1). Univariate analysis (Spearman's rho) was performed to assess the correlation between dependent and independent variables (not given here). For covariates, only those variables that showed a significant correlation with at least one of the outcome variables in univariate analysis were entered in regression models. Because the data were not normally distributed, the dependent variables were dichotomised by 25^{th} percentile to define poor physical HRQoL (≤ 33.67), poor mental HRQoL (≤ 50.5), and low life satisfaction (≤ 4). Multiple logistic regression (enter) analysis was performed by taking poor physical and mental HRQoL, and low life satisfaction as outcome variable, coded as "1".

In the logistic regression (enter) model, the response alternatives of ADL were reduced from five to three categories to increase the sample size in each category. In the crude model, association of nutrition risk with outcome variables was assessed, and in model 1, this association was adjusted for socio-demographic data. Then, in model 2, sociodemographics and health variables (functional ability and depression) were added. Among the five diseases, i.e., heart disease, diabetes, cancer, dementia, and depression, only depression was included in regression models, because in univariate analysis, it showed a significant correlation with the outcome variables. In regression analysis, well-nourishment, young age, male, and other characteristics with least association with low HRQoL, and life satisfaction were taken as reference categories. The results from regression models are presented as odds ratios (OR) with 95% confidence interval (CI). The Hosmer and Lemeshow goodness-of-fit test (30) was executed to determine whether regression models fit the data. Analyses were conducted using the statistical software SPSS-21 for Windows.

Results

Descriptive statistics

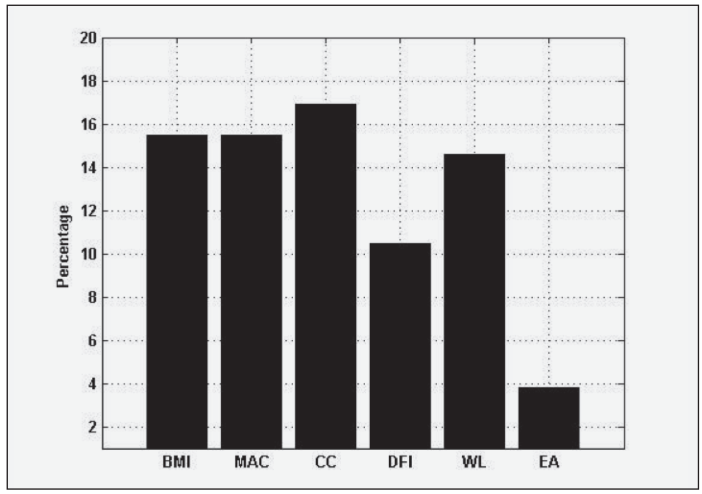
The mean age of the study sample was 76.7 years, and women composed 57.9% of the total population. According to the criterion, 8.5% were considered at risk of undernutrition. Subjects at risk of undernutrition were significantly older (mean age 84.2 years, p<0.001), and 73.8% of them were female. The comparison between the groups, at-risk and well-nourished reference group, showed that there were significant differences in relation to gender, marital status, and housing arrangement (p<0.001). The participants at risk of undernutrition were more likely to be unmarried/divorced/widowed (73% vs 44.8%) and reside in special housing (16% vs 4.7%) compared to the reference group (Table 1). Moreover, a significant (p<0.001) difference was observed regarding the distribution of different states of functional ability. The prevalence of mild, moderate, and severe impairment was higher in subjects at risk of undernutrition; in particular, the prevalence of total impairment was 5.9 times higher in the subjects at risk in comparison to the reference group (Table 1).

The comparison between groups showed significant differences regarding the mean values of BMI, MAC, and CC (p<0.001). The proportion of subjects with BMI < 23 kg/m^2, MAC≤ 25.5 cm and CC≤ 32 cm was significantly (p<0.001) higher in the risk group (67.1% vs 12.2%, 62.5% vs 10.8%, and 69.4% vs 11.7%, respectively) than the reference group. The same pattern was observed regarding the distribution of subjective measures between the groups (p<0.001): declined food intake, weight loss, and eating ability. The mean score of PCS-12 and MCS-12 was significantly (p<0.001) lower in the subjects at risk of undernutrition compared to the reference group (33.8, SD 11.6 vs 43.2, SD 11.2, and 49.4, SD 10.5 vs 54.6, SD 8.3, respectively). Furthermore, subjects at risk had significantly (p=0.002) lower life satisfaction (5.1, SD 2.7) than well-nourished subjects (6.2, SD 2.6, Table 1).

Prevalence of undernutrition in relation to each anthropometric and subjective measure

Prevalence of undernutrition explained by anthropometric measurements was higher than the subjective measures. Risk of undernutrition explained by BMI and MAC was the same (15.5%), but CC gave a slightly higher percentage, i.e., 16.9% (Figure 1). The prevalence of undernutrition in relation to declined food intake and weight loss was 10.5% and 14.6%, respectively, but needed help in eating gave the lowest percentage, i.e., 3.8%, among all six variables. It is evident that the prevalence of undernutrition is dependent on the measure used. However, if anthropometric and two subjective measures (decline in food intake and weight loss), measured by single items, are considered, the prevalence is between 10.5% and 16.9%, which is much higher compared to eating ability, i.e., 3.8%.

Figure 1
Prevalence of undernutrition by BMI, MAC, CC, declined food intake (DFI), weight loss (WL), and eating ability (EA)



Undernutrition and physical HRQoL

The crude model with nutritional status as the independent and low physical HRQoL as the outcome variable showed that the subjects at risk of undernutrition were 3.79 (95% CI 2.29-6.26) times more likely to have low physical HRQoL compared to well-nourished subjects. In model 1, association of nutritional status with low physical HRQoL was adjusted for socio-demographics (age, gender, marital status, housing arrangement, and education), and risk of undernutrition (OR 2.57, 95% CI 1.37-4.80), being female (OR 1.48, 95% CI 1.02-2.15), and higher age (OR 1.05, 95% CI 1.03-1.08) were significantly associated with low physical HRQoL. In model 2, health variables, functional ability and depression, were included in addition to the variables of model 1. The association between risk of undernutrition and low physical HRQoL remained significant after controlling for socio-demographics and health variables (OR 2.31, 95% CI 1.18-4.52), but association of age and gender with low physical HRQoL no longer remained significant. However, mild impairment in functional ability showed 4.13 higher odds (95% CI 2.47-6.91) for low physical HRQoL compared to good/excellent functional ability. Subjects with moderate to total impairment were 9.69 (95% CI 5.16-18.18) times more likely to have low physical HRQoL than the subjects with good/excellent functional ability (Table 2a). The association between risk of undernutrition and reduced physical HRQoL remained significant in all three models, but the importance of nutritional status decreased when control variables were included.

Table 2a

Logistic regression analysis (Enter) of nutritional status and confounders in relation to physical HRQoL (PCS-12)

Variables	Crude Model			Model 1			Model 2		
	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value
Nutrition status	3.79	2.29-6.26	<0.001	2.57	1.37-4.80	0.003	2.31	1.18-4.52	0.014
Gender				1.48	1.02-2.15	0.035	1.47	0.98-2.19	0.057
Age				1.05	1.03-1.08	<0.001	1.02	0.99-1.04	0.108
Marital status				1.00	0.67-1.49	0.980	0.90	0.58-1.39	0.647
Housing arrangement				1.07	0.51-2.24	0.843	0.55	0.24-1.26	0.162
Economic status (14000 SEK/week)				1.46	0.95-2.26	0.083	1.47	0.92-2.35	0.105
Education						0.199			0.472
Primary left at age 11-12				1.30	0.72-2.34	0.380	1.25	0.68-2.30	0.467
Secondary, left at age 14-16				1.23	0.60-2.53	0.563	1.01	0.47-2.17	0.973
High or Vocational left at 18-19				0.76	0.38-1.52	0.441	0.84	0.41-1.71	0.639
Depression							1.17	0.67-2.05	0.560
Functional ability									<0.001
Mild impairment							4.13	2.47-6.91	<0.001
Moderate, severe & total impairment							9.69	5.16-18.18	<0.001

Note: The 25th percentile of PCS-12, i.e., 33.67 was taken as the outcome variable. Model 1 was adjusted for socio-demographics and further in model 2, ADL and depression were added. Well-nourishment, young age, male, being married and the variables with least association to low quality of physical health were taken as reference categories. The significance value of Hosmer and Lemeshow test for model 1 was 0.13 and for model 2 was 0.90.

Table 2b

Logistic regression analysis (Enter) of nutritional status and confounders in relation to mental HRQoL (MCS-12)

Variables	Crude Model			Model 1			Model 2		
	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value
Nutrition status	2.55	1.53-4.23	<0.001	2.32	1.24-4.33	0.008	2.34	1.22-4.47	0.010
Gender				1.79	1.23-2.60	0.002	1.62	1.10-2.39	0.014
Age				1.04	1.02-1.06	<0.001	1.03	1.00-1.05	0.006
Marital status				1.09	0.73-1.63	0.648	1.03	0.68-1.55	0.885
Housing arrangement				0.64	0.29-1.43	0.285	0.51	0.22-1.17	0.112
Economic status (14000 SEK/week)				1.62	1.06-2.49	0.026	1.53	0.98-2.38	0.060
Education						0.126			0.143
Primary left at age 11-12				1.87	0.99-3.53	0.051	1.79	0.94-3.41	0.072
Secondary, left at age 14-16				1.22	0.56-2.67	0.607	1.09	0.49-2.44	0.817
High or Vocational left at 18-19				1.39	0.68-2.84	0.356	1.38	0.67-2.84	0.370
Depression							2.94	1.80-4.81	<0.001
Functional ability									0.010
Mild impairment							1.60	0.95-2.71	0.076
Moderate, severe & total impairment							2.46	1.33-4.55	0.004

Note: The 25th percentile of MCS-12, i.e., 50.50 was taken as the outcome variable. Model 1 was adjusted for socio-demographics and further in model 2, ADL and depression were added. Well-nourishment, being male, young age, being married and the variables with least association to low quality of mental health were taken as the reference categories. The significance value of Hosmer and Lemeshow test for model 1 was 0.54 and for model 2 was 0.86.

Table 2c

Logistic regression analysis (Enter) of nutritional status and confounders in relation to life satisfaction (LSI)

Variables	Crude Model			Model 1			Model 2		
	OR	95% CI	p-value	OR	95% CI	p-value	OR	95% CI	p-value
Nutrition status	1.88	1.14-3.11	0.013	1.33	0.72-2.44	0.349	1.30	0.70-2.40	0.396
Gender				1.43	1.01-2.03	0.040	1.35	0.95-1.93	0.093
Age				1.02	1.00-1.04	0.027	1.01	0.99-1.03	0.133
Marital status				1.98	1.37-2.88	<0.001	1.98	1.36-2.89	<0.001
Housing arrangement				1.18	0.58-2.40	0.630	1.00	0.48-2.08	0.994
Economic status (14000 SEK/week)				1.02	0.66-1.58	0.914	0.97	0.62-1.50	0.893
Education						0.276			0.361
Primary left at age 11-12				1.54	0.87-2.71	0.133	1.49	0.84-2.63	0.167
Secondary, left at age 14-16				1.46	0.73-2.92	0.282	1.38	0.68-2.78	0.365
High or Vocational left at 18-19				1.07	0.56-2.05	0.817	1.07	0.56-2.04	0.830
Depression							1.84	1.13-2.99	0.014
Functional ability									0.100
Mild impairment							1.16	0.70-1.92	0.554
Moderate, severe & total impairment							1.87	1.05-3.34	0.032

Note: The 25th percentile of LSI, i.e., 4 was taken as the outcome variable. Model 1 was adjusted for socio-demographics and further in model 2, ADL and depression were added. Well-nourishment, young age, male, being married and the variables with least association to low life satisfaction were taken as reference categories. The significance value of Hosmer and Lemeshow test was 0.83 for model 1 and 0.78 for model 2.

Undernutrition and mental HRQoL

In the crude model, the probability of low mental HRQoL was 2.55 (95% CI 1.53-4.23) times higher in the group at risk of undernutrition compared to the reference group. In model 1, being at risk of undernutrition (OR 2.32, 95% CI 1.24-4.33), being female (OR 1.79, 95% CI 1.23-2.60), being older (OR 1.04, 95% CI 1.02-1.06), and being unable to manage emergency expenditure in a week (OR 1.62, 95% CI 1.06-2.49) were significantly associated with low mental HRQoL. In model 2, adjusted for socio-demographics, depression, and functional ability, the probability of low mental HRQoL was 2.34 (95% CI 1.22-4.47) times higher in the at-risk group than the reference group. Being female (OR 1.62, 95% CI 1.10-2.39), higher age (OR 1.03, 95% CI 1.00-1.06) and depression (OR 2.94, 95% CI 1.80-4.81) were significantly associated with low mental HRQoL. Regarding functional ability, moderate to total impairment had 2.46 (95% CI 1.33-4.55) times higher odds for low mental HRQoL than good/excellent functional ability (Table 2b). The association between risk of undernutrition and low mental HRQoL remained stable, even after controlling for potential confounders.

Undernutrition and life satisfaction

In the crude model, the probability of low life satisfaction was 1.88 (95% CI 1.14-3.11) times higher in the group at risk of undernutrition compared to the reference group. In model 1, association between risk of undernutrition and low life satisfaction no longer remained significant after controlling for socio-demographics. In that model, being female (OR 1.43, 95% CI 1.01-2.03), higher age (OR1.02, 95% CI 1.00-1.04), and being unmarried/divorced/widowed (OR 1.98, 95% CI 1.37-2.88) were significantly associated with low life satisfaction. In model 2, no significant association was observed between nutritional status and low life satisfaction. However, being unmarried/divorced/widowed (OR 1.98, 95% CI 1.36-2.89) and depression (OR 1.84, 95% CI 1.13-2.99) were significantly associated with low life satisfaction (Table 2c).

Discussion

This study reported an 8.5% prevalence of undernutrition, and subjects at risk of undernutrition were significantly older, female, unmarried/divorced/widowed, special-housing residents, had impaired functional ability, and stated poor HRQoL and life satisfaction compared to the well-nourished subjects. The risk of undernutrition was independently associated with reduced physical and mental HRQoL, but not with low life satisfaction. Instead, depression and being unmarried/divorced/widowed mainly contributed to the low life satisfaction. Impaired functional ability contributed not only to poor physical and mental HRQoL but also to undernutrition.

The prevalence of undernutrition reported in this study is lower than that reported in other Swedish studies. The studies on home-living adults ≥ 71 years of age (13, 31) and hospitalised patients ≥ 65 years of age (32) by using the mini-nutritional assessment (MNA) as the diagnostic tool stated risk of undernutrition rates of 14.6%, 17%, and

55.1%, respectively. A study that used Swedish guidelines for nutritional risk assessment (10) reported 27% prevalence of undernutrition among hospitalised (mean age 69 years) and special-housing residents (mean age 85 years). Another study on special-housing residents (≥ 65 years) stated prevalence of undernutrition 32%-38%, by using combination of MNA, anthropometry, and serum protein measurements for nutritional status assessment (15). This variation in findings can be explained by the age criteria, setting, and tool for nutritional risk assessment. Thus, the lower prevalence in this study can be explained by age criteria ≥ 60 years and higher proportion of home living subjects compared to special housing residents (93.5% vs 6.5%), as the risk of undernutrition increases with aging (11) and special housing. This study aimed to be population based, and the proportion of special housing residents is similar to the proportion at national level of Sweden, but the participants in the present study were generally healthier than nonparticipants (23). Moreover, the majority of the respondents (68%) reported good/excellent functional ability, which is crucial for adequate dietary intake (4, 7, 33). Thus, the inclusion of a healthy subject population with good/excellent functional ability may explain the lower prevalence of undernutrition.

Another important explanation for the variation of results is the use of different assessment tools. It is a dilemma in nutritional studies that researchers use different tools and criteria for defining nutritional risk, which makes it difficult to make comparison across studies (6, 9, 11). To the best of our knowledge, the criterion used to define the risk of undernutrition in this study is new and has not been used before in previous research. In the present study, both Swedish and ESPEN guidelines were integrated in the selection of tools/variables, but not the criterion. According to Swedish guidelines (8), prevalence of any variable (BMI below cut-off, weight loss, and eating problems) demonstrates risk of undernutrition, but it is important to highlight that the results of this study showed that the use of only one variable may over-report or under-report the prevalence. This finding emphasises the importance of using a combination of different methods to overcome the limitations of one method, instead of relying on a single measure. Therefore, an index was developed in this study by the inclusion of anthropometric and subjective measures. Anthropometric measurements are precise, but subjective measures can predict the risk of undernutrition at an earlier stage, e.g., decline in food intake predicts nutritional risk prior to physiological changes. Furthermore, selection of a tool is also influenced by the population being studied (7), e.g., if eating ability is used for nutritional risk assessment in special housing, it will report high prevalence of undernutrition. This is because difficulty in eating is more frequent in special-housing residents (10) compared to home living individuals. The method used in this study for nutrition risk assessment included a variety of variables that can be used both for home-living and special-housing residents.

In addition to BMI, MAC and CC were included in this study. There is considerable evidence that MAC (34, 35) and CC (36) are better predictors of undernutrition than BMI. This is because BMI describes the relation of height to weight and cannot distinguish between fat or muscle depletion (27), oedema, and fat distribution (23). Therefore, it is useful to include muscle mass area, MAC and CC, to assess nutritional risk in elderly. The cut-offs of anthropometry to delineate the risk of undernutrition defined by the 15th percentile gave higher values, i.e., BMI < 23, MAC ≤ 25.5, and CC ≤ 32 than the standards of WHO, i.e., BMI <18.5, MAC ≤ 22, and CC ≤ 31. However, there is significant evidence to support using higher cut-offs for the elderly (37, 38, 39) due to different distribution of body fat and also to use the same cut-offs for elderly as for adults may increase the likelihood of delaying the detection of nutrition risk (37). Hence, the validity of the cut-offs and criterion used is evident from the significant differences (p-values<0.001) between the groups, those at risk of undernutrition and those considered well-nourished, for each anthropometry and subjective measures.

Nutrition screening is often resisted due to the lack of cost effectiveness and easy-to-administer assessment tools (7). The method used here is not only cost effective but also easy to implement, as it does not require clinical instruments or doctor visits and can be administered by a nurse or assistant. This method could be very useful to assess nutrition risk in the elderly and follow them over time because it requires less time to administer and exerts less burden on the subject population. However, it needs to be validated against a standardised method, e.g., MNA, before it could be implemented in population or clinical settings.

In this study, the subjects at risk of undernutrition were significantly older, female, and special-housing residents, and these findings are in agreement with previous research (11, 13, 40). The gender difference can be explained by "survival of the fittest". Males live a shorter time than females, and risk of undernutrition increases with aging. Thus, fewer males and more females in the older group make comparison difficult across gender (14). Regarding the high prevalence of undernutrition in special-housing residents, Johansson et al (13) argued that this fact indirectly emphasises the importance of nutritional risk screening at the community level. The studies on home living (13) and newly admitted nursing home residents (15) in the same municipality of Sweden reported prevalence of undernutrition 14.5% and 32%-38%, respectively. This situation suggests that the assessment of nutritional risk at the community level is often overlooked and that the situation gets worse over time. Therefore, nutritional screening in the community may help to reduce the higher rate of undernutrition at nursing homes. Another important finding of this study is that the prevalence of total functional impairment was 5.9 times higher in the subjects at risk of undernutrition compared to the reference group. A study on elderly in Israel stated significantly (p=0.03) higher prevalence of functional disability in undernourished subjects (41), while another study in Canadian functionally dependent elderly reported a lower dietary intake than the Canadian dietary recommendations of this age group (33). Thus, functional disability can be a predictor or outcome of undernutrition, but it is of great importance for both the prediction and prevention of undernutrition.

The findings of this study that the risk of undernutrition has an independent association with poor HRQoL are in line with the results of other studies (17, 18, 22, 42). The correlation of undernutrition with HRQoL in elderly can be direct, as lower energy intake may influence subjective perception of well-being, or it could be indirect, by decreasing functional ability. Muscle mass depletion is common phenomenon of aging, and the presence of undernutrition exacerbates this condition (43) and may cause progression to frailty and/or functional disability, which in turn lead to poor HRQoL. The present study highlights the importance of adequate nutrition and functional ability for good HRQoL and indirectly underlines the importance of physical activity to preserve functional capacity by improving muscle mass and appetite (43).

It is interesting to note that in this study, no significant association was observed between nutritional status and life satisfaction, which contradicts the findings of a prospective study on functionally dependent Canadian elderly (21). A few possible explanations of these incompatible results are as follows: an 11-item tool was used in this study, functional ability was controlled as a confounder, and the association was adjusted for covariates. In the study by Keller et al, (21), a single-item tool was used, instrumental functional dependency was one of the inclusion criteria, and adjusted analysis was not performed. There is considerable evidence that impaired functional ability (44, 45) and depression (46, 47) are significant predictors of low life satisfaction. In present study, the significant association of depression and marital status with low life satisfaction suggests that their presence may underrate the importance of nutritional status for life satisfaction, as it was significant in the crude analysis. However, lack of research on the association between nutrition and life satisfaction limits comparison between studies.

The strengths of this study are as follows. First, the subject population was composed of both home living and special housing residents; therefore, the results can be generalised to an older population. Second, both objective and subjective measures were used in combination for nutritional risk assessment. Objective measures are dominant in precision, and subjective measures help to explain the subjective perception of well-being. Third, several controlling variables were used, and the selection of confounders was very relevant to the outcome measures, e.g., depression and functional ability, etc.

Limitations of the study might include the use of a cross-sectional design, which gives information only about the association between two variables and limits the inference of a causal relationship with time. Therefore, it is hard to say whether undernutrition leads to low HRQoL or vice versa. This uncertainty underlines the need for prospective studies to elucidate the impact of each variable over time. Another limitation could be the use of the same cut-offs of MAC and CC for males and females, which may influence the results. Moreover, the impact of physical activity was not included in this study, and physical activity may influence nutritional status and functional ability, which contributed to poor QoL.

Conclusions

In this study on people 60 years of age and above, 8.5% of subjects were found at risk of undernutrition. The at-risk individuals were significantly older, female, unmarried/widowed/divorced, special housing residents, and functionally impaired. In addition, the risk of undernutrition showed an independent association with poor HRQoL. A causal relationship cannot be inferred due to the cross-sectional design, but the study highlights the detrimental effect of risk of undernutrition with poor HRQoL in the elderly, which is modifiable. Thus, these findings emphasise the importance of identifying and modifying the risk factors of undernutrition for both the prevention of undernutrition and the promotion of HRQoL.

Depression and being unmarried/widowed/divorced, rather than undernutrition, were significant contributors of low life satisfaction. This adds the importance of covariates in exploring the true association between nutritional status and life satisfaction, which is lacking in previous studies. Another interesting finding is the importance of functional ability for the main variables, i.e., nutrition and QoL. This correlation goes in both ways; as a predictor or outcome. However, consideration of functional ability may help in the planning of interventions to mitigate the risk of undernutrition and promotion of QoL in older populations.

Ethical Standards: According to Swedish integrity and security law, informed consent is needed before gathering the data on individuals from different sources. In SNAC-B, verbal informed consent was used for questionnaires and written informed consent was used for medical examination. The SNAC-B study is approved by the ethics committee of Lund University (LU 605-00, LU 744-00).

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