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Association between living setting and malnutrition among older adults: The PEN-3S study

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ABSTRACT

Objectives: Malnutrition is frequent among older adults, especially those living in nursing homes, but the association between residential setting and nutritional status is controversial. The aim of this study was to examine the association between living setting (nursing home versus community) and malnutrition while adjusting for demographic, socioeconomic, health-related, and psychosocial factors.
Methods: This cross-sectional study included a randomly selected representative sample of Portuguese adults ≥65 y of age. Interviewers collected data regarding demographic and socioeconomic characteristics, nutritional status, physical activity, energy intake, cognitive function, self-reported general health, functional status, symptoms of depression, and loneliness. Logistic regression models were used to estimate the association between residential setting and malnutrition.
Results: Participants were 1186 nursing home residents (72.8% women, 49.2% ≥85 y of age) and 1120 community dwellers (49% women, 21.3% ≥85 y of age). Following Mini Nutritional Assessment (MNA®) criteria, 29.6% of nursing home residents and 14.1% of community dwellers were at risk of malnutrition, whereas 2.3% and 0.3%, respectively, were malnourished. The living setting was not significantly associated with malnutrition after adjusting for functional status, symptoms of depression, and feelings of loneliness (odds ratio, 1.03; 95% confidence interval, 0.67–1.58).
Conclusions: Risk of malnutrition and malnutrition are more prevalent among nursing home residents than community dwellers. Physical (functional status) and mental health (symptoms of depression and loneliness) seems more relevant to nutritional status than residential setting by itself. These findings should be taken into account when designing public health policies to tackle malnutrition among older adults.
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Introduction

The demographic projections for the European Union estimate that the ratio of people ≥65 y of age, relative to those 15 to 64 y of age, will increase from 29.6% in 2016 to 51.2% in 2070 [1]. These trends pose unique challenges to health care, long-term care, and social protection systems [1,2]. At the same time, older adults are tremendously valuable to society, contributing unique knowledge and experience to the labor market, within their families, or with volunteer activities [3]. Even more, there is evidence that promoting healthy aging has a positive economic return, contradicting negative stereotypes toward older individuals [4]. For this to happen, it is crucial that people preserve their functional ability as they age [2]. The World Health Organization defines *functional ability* as the health-related attributes that enable individuals to be and to do what they value, and it is considered a central topic when discussing aging [5].

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In fact, after a tremendous increase in life expectancy, one of the greatest challenges currently is to "add health to these years" [2,5].

Numerous biological, psychological, and social changes occur as part of the aging process [5]. Additionally, a great number of health problems prevail in the last decades of life, also related to age-dependent transformations [6]. However, not every individual of the same age is affected equally, probably owing to interindividual differences in lifetime interactions between genetics, individual factors, and the environment [7]. A relevant proportion of older individuals become dependent on caregivers for everyday activities sooner than desirable [8,9]. This is one of the main reasons why older individuals move in to institutions that provide some sort of formal care and support according to their needs [9,10].

Nutrition plays a major role in determining functional ability and well-being in older age [11,12]. In the particular case of malnutrition, it affects quality of life by undermining individuals' autonomy to perform basic, instrumental, and social activities of daily living [13]. Under the scope of the present study, *malnutrition* refers to "a state resulting from lack of intake or uptake of nutrition that leads to altered body composition (decreased fat-free mass) and body cell mass leading to diminished physical and mental function and impaired clinical outcome from disease", as endorsed by ESPEN [14]. Malnutrition, referred here as a synonym of undernutrition, is prevalent among older people, but it is still frequently underrecognized [15,16]. Malnutrition is a complex public health challenge with multiple causes and serious health consequences [17]. Furthermore, increased risk of malnutrition is associated with other prevalent aging-related problems, such as cognitive impairment, depression, and loneliness, and it is not consensual which comes first [18,19]. Thus, a comprehensive analysis on the nutritional status of older individuals also requires the examination of those factors. Moreover, malnutrition prevalence seems to rise with increasing levels of dependence and illness [15]. It is more frequent among hospitalized older adults than in those living in nursing homes (NHs) and less frequent, but still relevant, in community dwellers (individuals living at home) [15,20].

A plethora of literature has been published in recent years concerning the prevalence, determinants, and outcomes of malnutrition associated with aging [18,21–24], and results are consistent with malnutrition being more prevalent in NHs than in the community. This general observation raises two main questions. First, does living in a NH, by itself, increase the likelihood of malnutrition? If not, does the effect of demographic, socioeconomic, health-related, lifestyle, and psychosocial factors on nutritional status differ between living settings? Evidence based on national representative samples from different settings while controlling for potential malnutrition-associated factors is limited [21]. Therefore, this study aimed to (a) examine the association between living setting (NH versus community) and risk of malnutrition or malnutrition, while adjusting for demographic, socioeconomic, health-related, and psychosocial factors, and to (b) investigate whether the associations between those factors and nutritional status differ according to residential setting among Portuguese adults ≥65 y of age. This research topic is highly relevant; as the older population continues to grow, the number of persons in need of specialized care also increases, and malnutrition potentially becomes more frequent. Thus, comprehensive knowledge on the nutritional status and associated conditions in different living settings has the potential to inform effective and targeted healthy aging policies.

Methods

Study design and participants

This study presents data from the Portuguese Elderly Nutritional Status Surveillance System (PEN-3S) project. PEN-3S is a cross-sectional study focused on the nutritional status of the Portuguese community dwellers and NH residents ≥65 y of age (without upper age limit). The PEN-3S study protocol is detailed elsewhere, including sample size estimates to ensure a nationally representative sample [25].

In this study, the term *nursing home* refers to the general setting of residential care intended for older adults and providing social support activities and nursing care, as described elsewhere [26]. For the NH setting, a random cluster sampling (NHs as clusters) was performed in each of the seven Portuguese main regions (NUTS II; Nomenclature of Territorial Units for Statistics, as defined by the European Union). All NHs registered with the Portuguese Social Security Institute, which is compulsory, were randomly listed, separately for each region. Institutions were then formally invited to participate in sequence order until the minimum target sample size in each region was achieved. All individuals ≥65 y of age living in the participating institutions and without any of the exclusion criteria were invited, face-to-face, to enroll in the study.

Data regarding the community sample resulted from collaboration between the PEN-3S project and the National Food, Nutrition and Physical Activity Survey (IAN-AF 2015–2016). As previously described, the IAN-AF team followed a multistage approach sampling [27]. First, there was a random selection of primary health care units stratified by the seven NUTS II, weighted by the number of individuals registered in each unit. After that, registered individuals in each health unit were randomly selected from the National Health Registry according to sex and age groups, and were invited to participate by telephone and letter.

Exclusion criteria were the following:

- individuals living in Portugal for <1 y;
- non-Portuguese speakers;
- absence from the NH during data collection (e.g., owing to hospitalization);
- unable to understand or answer the questionnaire owing to dementia, psychiatric disease, or severe hearing or visual impairment; and
- bedridden individuals.

Individuals living in collective residences or institutions (e.g., hospitals, prisons, or military barracks) were also excluded from the community sample. The interviews were scheduled to be held over the next few days with those who accepted to participate and provided written informed consent.

Data collection procedures and instruments

Trained nutritionists performed data collection between October 2015 and September 2016 using a computer-assisted face-to-face structured interview, which also included anthropometric measurements, either at the NH, primary care unit, or participant's home. Data were collected regarding demographic and socioeconomic characteristics (age, sex, education, marital status, and monthly income), self-reported morbidity, self-reported health, physical activity, dietary and nutritional intake, nutritional status (anthropometry and Mini Nutritional Assessment [MNA®]), cognitive function, symptoms of depression, feelings of loneliness, and functional status. IAN-AF methods was followed to collect data on demographics, socioeconomic status, diet, physical activity, and morbidity using the platform YOU eAT&MOVE, developed by IAN-AF [27].

Single-item measures were used to assess demographic and socioeconomic characteristics, self-reported morbidity ("yes" or "no" answer regarding cardiac disease, type 2 diabetes mellitus, hypertension, dyslipidemia, gastrointestinal disease, arthritis, and osteoporosis) and self-reported health on a scale from 1 (*excellent*) to 5 (*very poor*) [28]. The Mini Mental State Examination (MMSE) was used to assess cognitive function [29]. MMSE cutoffs that determine cognitive impairment have been studied in the Portuguese population and vary according to the number of years attending school: 0 y ≤15 points; 1 to 11 y ≤22 points; >11 y ≤27 points [30]. In the present study, only sociodemographic data and nutritional status (anthropometric measures and MNA) were obtained and will be presented for participants classified as being cognitively impaired. The International Physical Activity Questionnaire (IPAQ) short-form (nine-item) was performed to collect data on the time spent walking, performing vigorous and moderate intensity activities, and in sedentary activities [31]. IPAQ guidelines were followed to categorize individuals' physical activity level as low, medium, or high. Mean daily energy intake was estimated based on two non-consecutive 24-h recalls (five-step multipass method; 8–15 d apart) with food pictures for portion size evaluation using an electronic assessment tool. This tool was developed by the IAN-AF team in accordance with guidelines from the European Food Safety Agency (EFSA) [32] and was linked with the nutritional composition data of traditional foods and recipes [27]. Nutritional status was assessed using the full MNA (18-item) [33–35]. This instrument includes four dimensions: anthropometry; dietary assessment; self-perception of nutritional status and health; and a general evaluation of lifestyle, medication, depression, and dementia. According to MNA cutoffs, individuals were classified as normal nutritional status, at risk of malnutrition, or malnourished. Weight, height, hand length, and arm and calf

circumferences were measured with individuals wearing minimal clothing and no shoes, and following the International Standards for Anthropometric Assessment (ISAK), as described elsewhere [25,36]. In 398 NH residents and 198 community dwellers, it was not possible to measure height, and thus hand length was used to estimate it using validated equations for the Portuguese population [37]. This is a fast, simple, and low-invasive method, which has proven to be a reliable approximation to height given small differences between measured and estimated heights and the strong correlation between height and hand length [37]. Body mass idex (BMI) was obtained by dividing weight (in kilograms) by the square of height (in meters). When weight was not possible to measure, the MNA version using calf circumference instead of BMI was used [38]. The 15-item version of the Geriatric Depression Scale (GDS-15) is a widely used screening instrument in epidemiologic studies, and it was employed to classify participants as presenting symptoms of depression (score <5) or not [39,40]. The instrumental activities of daily living (IADLs) were assessed with the Lawton Scale [41]. This scale measures both cognitive and physical function to perform IADLs, such as using the phone or preparing food. Scores range from 0 to 8, and a score <8 was used to classify individuals as having some degree of dependence. Finally, the UCLA Loneliness Scale was administered to study subjective feelings of loneliness and social isolation [42]. Taking into consideration the validated cutoffs for the Portuguese population, a score >32 points indicated the presence of feelings of loneliness [43].

Statistical methods

Statistical analyses were performed using SPSS version 24 (IBM, Armonk, NY, USA) assuming a statistical significance level of 5%. Descriptive statistics are presented as frequencies (%) or mean and SD. For the entire sample, descriptive statistics on demographic and socioeconomic data and nutritional status are provided, whereas the remaining variables (self-reported morbidity, self-reported health, physical activity, functional status, symptoms of depression, and feelings of loneliness) are only reported for those who were not cognitively impaired. Because the main goal of the present study was to describe the association between living setting and malnutrition, MNA item G ("Lives independently [not in nursing home or hospital]") was removed and the original cutoff values were proportionally adjusted (normal nutritional status: 23.2–29 points, at risk of malnutrition: 16.4–23.1 points, malnourished: <16.4 points). χ^2 tests (categorical variables) were used to compare groups, namely to compare the normal nutritional status group with the risk of malnutrition or malnutrition (all together) group. To study the association between living setting and risk of malnutrition (objective a, see Introduction section), the likelihood of being malnourished or at risk of malnutrition was calculated through logistic regression models by progressively adjusting the variable setting to demographic and socioeconomic variables, physical health-related variables, and psychosocial variables (models 1.1–1.5).

To investigate whether the associations between demographic, socioeconomic, health-related, lifestyle, and psychosocial factors and nutritional status differ according to residential setting (objective b), two strategies of analysis were followed. First, two logistic regression models were conducted to estimate the associations between malnutrition status (dependent variable combining risk of malnutrition and malnutrition) and the other variables under study (demographic, socioeconomic, health-related, lifestyle, and psychosocial), separately for the two settings (NHs versus community). Model 1 was adjusted for sex and age, whereas in addition to sex and age, model 2 was further adjusted for monthly income, self-reported health, and symptoms of depression. Independent variables were entered as a block in a single step ("Enter" method). The following pairs of variables conveyed essentially the same information, being highly associated (not independent): monthly income and marital status, self-reported health and functional status, symptoms of depression and loneliness. Therefore, marital status, functional status, and feelings of loneliness were excluded from the final model. Physical activity and mean daily energy intake were also excluded from the final model once they are directly involved in the etiology of malnutrition through energy balance [16]. Finally, the second strategy to address whether the associations between demographic, socioeconomic, health-related, lifestyle, and psychosocial factors and nutritional status differ according to residential setting (objective b) involved interaction testing using regression models. In each model, the interaction term was introduced as follows: independent variable in test × living setting.

Ethical standards

This study was conducted according to the ethical standards laid down in the Declaration of Helsinki. All procedures involving humans were approved by the National Data Protection Committee, the Faculdade de Medicina, Universidade de Lisboa Ethics Committee, and all seven Regional Health Administrations Ethics Committees. Data collection was also formally authorized by participating NHs and primary health care units. Written informed consent was obtained from all participants. When risk of malnutrition or malnutrition were identified, participants received an informative form about their status and were advised by interviewers (nutritionists) to contact their medical doctors.

Results

Sample characterization

Overall, 1186 NH residents and 1120 community-dwelling older adults, from all seven NUTS II regions, agreed to participate in this study. Participation rates (given as the ratio accepted/invited to enroll) were 93% and 23%, respectively. Demographic, socioeconomic, health, and lifestyle characteristics of both subsamples are presented in Table 1, which shows data for all participants (total sample) and separately for those without cognitive impairment (577 NH residents and 928 community-dwelling participants).

Concerning the total sample, when comparing NH residents with community-dwellers, 72.8% versus 49.0% were women, 49.2% versus 21.3% were ≥85 y of age (mean ± SD: 83.4 ± 7.1 versus 75.9 ± 8.1 y of age), 69.3% versus 36.5% were divorced or widowed, and only 11.0% versus 28.4% attended school for >4 y.

Following MMSE criteria, 48.7% of NH residents versus 82.9% of those living in the community were considered to be non-cognitively impaired and able to complete the full interview. The aforementioned sociodemographic differences between settings remained when considering exclusively participants without cognitive impairment. Moreover, non-cognitively impaired participants were younger, attended school for a longer period, were less frequently divorced or widowed, and had a higher monthly income compared with the total sample.

Regarding health status, when placing non-cognitively impaired NH residents side by side with their community-dwelling counterparts, 66.0% versus 72.2% reported having at least one disease that required regular health care, 60.6% versus 63.4% had a clinical diagnosis of hypertension, and 40.7% versus 23.7% rated their general health as *poor* or *very poor*. Moreover, 75.2% versus 41.4% reported a low level of physical activity based on IPAQ, and 83.7% versus 30.8% presented some degree of dependence in IADLs. Furthermore, although almost half (48.8%) of the NH sample presented symptoms of depression, and 38.8% reported subjective feelings of loneliness, these percentages were 22.3% and 11.8%, respectively, among community dwellers.

Among non-cognitively impaired NH residents, 29.6% were at risk of malnutrition and 2.3% were malnourished, according to MNA (Table 2). In the community sample, 14.1% and 0.3% of non-cognitively impaired older adults were at risk of malnutrition and malnourished, respectively. In both settings, the percentage of risk of malnutrition was higher for women (NH: 33%, community dwellers: 18.1%) than for men (NH: 21.8%, $P = 0.009$; community dwellers: 10.3%, $P = 0.001$) and for those classified as cognitively impaired (NH: 48.5%, $P < 0.001$; community dwellers: 39.5%, $P < 0.001$).

Living setting and malnutrition

To investigate the relationship between living setting and malnutrition, all non-cognitively impaired NH residents and community-dwelling older adults were simultaneously included in the regression models presented in Table 3. The NH setting was significantly associated with increased odds of being at risk of malnutrition or malnourished (odds ratio [OR], 1.70, 95% confidence interval [CI], 1.22–2.38), when adjusting for sex, age, and monthly income (model 1.2). However, when functional status to perform IADLs was included in the model, that association was no longer statistically significant (OR, 1.35; 95% CI, 0.91–2.02, model 1.4). Furthermore, in the last step, when symptoms of depression and feelings of loneliness were added,

Table 1
Demographic, socioeconomic, and health-related characteristics of all participants and non-cognitively impaired participants by setting (NH vs community)

	All participants		Non-cognitively impaired participants*	
	NH residents n (%)	Community dwellers n (%)	NH residents n (%)	Community dwellers n (%)
Total	1186	1120	577	928
Sex				
Women	864 (72.8)	549 (49.0)	403 (69.8)	451 (48.6)
Men	322 (27.2)	571 (51.0)	174 (30.2)	477 (51.4)
Age, y				
65–74	143 (12.1)	561 (50.1)	86 (14.9)	533 (57.4)
75–84	460 (38.8)	320 (28.6)	229 (39.7)	259 (27.9)
≥85	583 (49.1)	239 (21.3)	262 (45.4)	136 (14.7)
Marital status				
Single	212 (17.9)	48 (4.3)	106 (18.4)	39 (4.2)
Divorced or widowed	822 (69.3)	408 (36.5)	403 (69.8)	306 (33.1)
Married or living together	152 (12.8)	661 (59.2)	68 (11.8)	581 (62.7)
Years of education				
<5	1055 (89.0)	800 (71.6)	485 (84.1)	634 (68.3)
≥5	131 (11.0)	318 (28.4)	92 (15.9)	294 (31.7)
Monthly income, USD				
<$534	357 (30.2)	200 (17.9)	228 (39.5)	153 (16.5)
$534–$1068	208 (17.6)	382 (34.2)	139 (24.1)	329 (35.5)
>$1068	72 (6.1)	374 (33.5)	58 (10.1)	346 (37.4)
Do not know/No answer	545 (46.1)	160 (14.4)	152 (26.3)	98 (10.6)
Having disease that requires regular health care (% yes)	–	–	380 (66.0)	667 (72.2)
Clinical diagnosis (% yes)				
Cardiac disease	–	–	219 (38.0)	242 (26.1)
Type 2 diabetes mellitus	–	–	169 (29.3)	233 (25.2)
Hypertension	–	–	349 (60.6)	586 (63.4)
Dyslipidemia	–	–	267 (46.4)	480 (51.8)
Gastrointestinal disease	–	–	152 (26.4)	152 (16.4)
Arthritis	–	–	154 (26.7)	108 (11.7)
Osteoporosis	–	–	127 (22.0)	125 (13.5)
Self-reported health				
Excellent or good	–	–	78 (13.6)	268 (29.1)
Fair	–	–	262 (45.7)	434 (47.2)
Poor or very poor	–	–	233 (40.7)	218 (23.7)
Physical activity level				
Low	–	–	425 (75.2)	366 (41.4)
Moderate or high	–	–	140 (24.8)	518 (58.6)
Functional status (IADLs, % dependent)	–	–	476 (83.7)	252 (30.8)
Symptoms of depression (% yes)	–	–	281 (48.8)	206 (22.3)
Feelings of loneliness (% yes)	–	–	221 (38.8)	96 (11.8)

IADL, instrumental activities of daily living; NH, nursing home
*Mini Mental State Examination score >15 points (0 y of school), >22 points (1–11 y of school), <27 points (>11 y of school).

the OR for risk of malnutrition or malnutrition was near 1 (OR, 1.03; 95% CI, 0.67–1.58, model 1.5). The percentage explained by this last model is around 63%, and model 2 (last significant association) explained 38.8%.

Nutritional status–associated factors by living setting

Table 4 presents estimates for the associations between variables under study and malnutrition status by living setting. Logistic

Table 2
Distribution of the sample by MNA categories* according to cognitive function and living setting: NH residence or community, by sex

	Cognitively impaired		Non-cognitively impaired†	
	NH residents n (%)	Community dwellers n (%)	NH residents n (%)	Community dwellers n (%)
MNA without item G (women)				
Malnutrition	23 (5.0)	2 (2.1)	11 (2.7)	3 (0.7)
Risk of malnutrition	234 (50.9)	47 (48.4)	133 (33.0)	81 (18.1)
Normal nutritional status	203 (44.1)	48 (49.5)	259 (64.3)	364 (81.2)
MNA without item G (men)				
Malnutrition	5 (3.4)	3 (3.2)	2 (1.2)	0 (0.0)
Risk of malnutrition	61 (41.2)	28 (30.1)	38 (21.8)	49 (10.3)
Normal nutritional status	82 (55.4)	62 (66.7)	134 (77)	425 (89.7)
MNA without item G (total sample)				
Malnutrition	28 (4.6)	5 (2.6)	13 (2.3)	3 (0.3)
Risk of malnutrition	295 (48.5)	75 (39.5)	171 (29.6)	130 (14.1)
Normal nutritional status	285 (46.9)	110 (57.9)	393 (68.1)	789 (85.6)

MNA, Mini Nutritional Assessment; NH, nursing home
*Missing values for MNA: NH = 1; community = 8.
†Mini Mental State Examination >15 points (0 y of school), >22 points (1–11 y of school), <27 points (>11 y of school).

Table 3
OR for likelihood of being at risk of malnutrition or malnourished according to living setting (NH vs community) among Portuguese older adults without cognitive impairment*

Model	OR (95% CI)	Explained (%)
1.1: Living setting (NH vs community)	2.78 (2.16–3.58)†	–
1.2: Model 1.1 + sex, age, and monthly income	1.70 (1.22–2.38)†	38.8
1.3: Model 1.2 + self-reported health	1.52 (1.07–2.18)†	45.3
1.4: Model 1.3 + functional status (IADLs)	1.35 (0.91–2.02)	51.4
1.5: Model 1.4 + symptoms of depression and feelings of loneliness	1.03 (0.67–1.58)	62.9

IADL, instrumental activities of daily living; NH, nursing home
*ORs were estimated using logistic regression models.
†$P < 0.05$.

regression models adjusted for age and sex showed that the lowest quartile for daily energy intake, *poor* or *very poor* self-reported health, IADLs dependence, experiencing symptoms of depression and feelings of loneliness were all significantly associated with increased odds of being at risk of malnutrition or malnourished (all together), for both living settings (model 1, Table 4). Moreover, a lower monthly income for NH residents and a low physical activity level for community-dwelling older adults were significantly associated with risk of malnutrition or malnutrition.

When models were further adjusted for other variables in study, the associations with IADLs functional status (for the community setting) and loneliness were no longer significant (model 2, Table 4). On the contrary, positive significant associations with malnutrition remained for the lowest quartile of energy intake and for low levels of physical activity (for the community setting). When testing the possible modifying effect of living setting on the association between malnutrition and each of the studied variables, a significant interaction was only found for physical activity.

In the final adjusted model, a monthly income of $534 to $1068 (OR, 2.58; 95% CI, 1.07–6.23), reporting a very poor or poor general health status (OR, 3.54; 95% CI, 1.42–8.82), and symptoms of depression (OR, 4.96; 95% CI, 2.93–8.41) were associated with higher odds of being malnourished or at risk of it among the NH residents (model 2, Table 4). Among the community-dwelling older adults, a poorer self-rated health (OR, 3.54; 95% CI, 1.71–7.32) and the presence of symptoms of depression (OR, 5.12; 95% CI, 3.18–8.25) were significantly associated with increased odds of risk of malnutrition or malnutrition in the final adjusted model.

Discussion

To our knowledge, this was the first study to describe the association between nutritional status and living setting (NH versus community) in a large national representative sample of older adults without upper age limit, controlling for demographic, socioeconomic, health-related, and psychosocial variables. This study showed that the setting was not significantly associated with risk of malnutrition or malnutrition after adjusting for IADLs functional status, symptoms of depression, and loneliness.

Other studies have concluded that living in NHs is associated with higher risk of malnutrition among older adults after adjusting for several factors [23]. However, previous evidence should be carefully examined with regard to the adjustment variables that were included in the models [23]. Sociodemographic variables, self-reported health status, and long-standing illness were taken into consideration in a study reporting that living in an institution was associated with increased odds of malnutrition in men [44]. Others have reported the same association for both sexes when further controlling for polypharmacy [45]. However, these findings were not adjusted for functional status, which appears to be a key factor in this context. In fact, a study conducted in a Japanese city (N = 1098) showed that the NH setting was no longer significantly associated with malnutrition when basic ADL scores were included in the analysis [46]. Likewise, in the present study, IADL functional status, symptoms of depression, and feelings of loneliness appeared to be more significant to nutritional status than the living setting itself. As a matter of fact, resident-related factors like age, depression, impaired function, and poor oral intake have been associated with nutritional status [23,47]. Moreover, evidence points out that, in NHs, encouragement by caregivers, feeding assistance, and a pleasant ambiance seem particularly important to nutritional intake [48]. Residents' nutritional status also depends on access to nutritional support, quality, and nutritional adequacy [10]; however, these variables were not explored here.

In the present study, malnutrition was more frequent in the NH sample, as expected. This finding is probably related to specific characteristics of NH residents, like older age, predominance of women, cognitive impairment, existence of other diseases, and higher level of dependence. These observations are in line with results from other studies [15,24,49]. Despite the prevalence differences between settings, community-dwellers are the vast majority of older adults, meaning that, in absolute terms, risk of malnutrition most certainly affects more persons in the community than in NHs [24].

The prevalence of risk of malnutrition and malnutrition among individuals without cognitive impairment reported here is similar to two Spanish studies, one including a representative sample of the NH population without cognitive impairment and other with a very low percentage (6.5%) of cognitively impaired community-dwelling older adults [19,50]. However, recent meta-analysis and systematic reviews usually describe higher prevalence, both among community-dwellers and NH residents in Europe, although high heterogeneity was found among studies, even within the same setting [15,24,49]. This heterogeneity may be partly explained by the characteristics of the studied samples, such as cognitive function (cognitively impaired versus non-impaired) [23], sampling frame (e.g., primary care facilities, hospital outpatients, receiving home care) [24], or geographic area (rural versus urban areas) [24].

Evidence on differences among settings with regard to malnutrition-associated variables is scarce, given that only a few studies have used adjusted multiple analysis and large samples [51]. This study further advances the knowledge by estimating the ORs for the associations between several demographic, socioeconomic, health-related, lifestyle, and psychosocial variables and malnutrition status in each of the studied settings (NH versus community). In the present study, all models were controlled for age and sex, as residents from NHs were older and more frequently women, as reported by others [49].

A monthly income of $534 to $1068, reporting a very poor or poor health status and symptoms of depression were associated with higher chances of NH residents being at risk of malnutrition or malnourished (final adjusted model). A lower monthly income may limit the acquisition of sufficient amounts of nutritious food, leading to risk of malnutrition, but this association was not expected in NH. Nursing home fees include all meals and, in the vast majority of these facilities, residents' monthly fee depends on their income. However, fees vary among institutions and food offers may also differ. Another possibility is that foods eaten or brought in from the outside the NH affects residents' nutritional status. Still, to our knowledge, there is no data available that could support these hypotheses. Monthly income may also be acting as proxy of other malnutrition-associated factors. Regarding community-dwelling older adults, only a poorer self-rated health and the presence of depression symptoms were significantly associated with increased odds of risk of malnutrition or malnutrition. Self-

Table 4
Associations between demographic, socioeconomic, health-related, lifestyle, and psychosocial variables and malnutrition status according to residential setting (NH vs community) among Portuguese older adults without cognitive impairment*

		Model 1† OR (95% CI)		Model 2†,‡ OR (95% CI)		
		NH residents vs community dwellers	Community dweller	NH n = 423	Community dweller n = 816	$P_{interaction}$§
Sex	Men	1	1	1	1	0.800
n = 577; 922‖	Women	1.80 (1.20–2.72)¶	2.05 (1.40–3.00)¶	1.19 (0.69–2.05)	1.14 (0.72–1.79)	
Age, y	65–74	1	1	1	1	0.328
n = 577; 922	75–84	1.30 (0.73–2.32)	2.02 (1.33–3.06)¶	1.07 (0.49–2.36)	1.41 (0.86–2.31)	
	≥85	1.88 (1.07–3.30)¶	1.85 (1.10–3.10)¶	1.35 (0.63–2.92)	1.55 (0.83–2.89)	
Marital status	Married or living together	1	1	1	1	0.753
n = 577; 920	Single	1.05 (0.50–2.19)	1.26 (0.52–3.06)	3.27 (1.23–8.69)¶	1.67 (0.57–4.88)	
	Divorced or widowed	1.40 (0.75–2.59)	1.23 (0.81–1.89)	1.78 (0.78–4.03)	1.17 (0.70–1.96)	
Monthly income, USD	<$534	2.35 (1.09–5.10)¶	1.54 (0.89–2.69)	2.11 (0.90–4.94)	1.45 (0.79–2.66)	0.331
n = 425; 822	$534–$1068	3.01 (1.35–6.69)¶	1.54 (0.97–2.43)	2.58 (1.07–6.23)¶	1.26 (0.76–2.08)	
	>$1068	1	1	1	1	
Energy intake (kcal/d, quartiles)	Q1	2.32 (1.34–4.01)¶	3.95 (2.06–7.60)*	2.13 (1.01–4.50)¶	3.18 (1.55–6.52)¶	0.305
n = 572; 918	Q2	1.65 (0.96–2.86)	1.86 (0.95–3.64)	1.85 (0.89–3.85)	1.80 (0.86–3.76)	
	Q3	0.93 (0.53–1.65)	1.67 (0.85–3.28)	0.93 (0.44–1.97)	1.51 (0.73–3.14)	
	Q4	1	1	1	1	
Physical activity level	Low	0.89 (0.59–1.36)	2.04 (1.36–3.04)¶	0.79 (0.45–1.39)	1.73 (1.08–2.77)¶	0.003¶
n = 565; 880	Moderate or high	1	1	1	1	
Self-reported health	Excellent or good	1	1	1	1	0.429
n = 573; 914	Fair	1.26 (0.61–2.58)	2.00 (1.09–3.66)¶	1.08 (0.43–2.72)	1.72 (0.87–3.41)	
	Poor or very poor	6.12 (3.05–12.30)¶	6.29 (3.43–11.54)¶	3.54 (1.42–8.82)¶	3.54 (1.71–7.32)¶	
Functional status (IADLs)	Independent	1	1	1	1	0.325
n = 569; 814	Dependent	3.13 (1.68–5.84)¶	2.18 (1.40–3.40)¶	2.44 (1.09–5.48)¶	1.27 (0.75–2.15)	
Symptoms of depression	Absence	1	1	1	1	0.802
n = 576; 920	Presence	5.88 (3.91–8.85)¶	5.99 (4.02–8.95)¶	4.96 (2.93–8.41)¶	5.12 (3.18–8.25)¶	
Feelings of loneliness	Absence	1	1	1	1	0.086
n = 569; 814	Presence	2.18 (1.51–3.15)¶	3.53 (2.13–5.84)¶	1.63 (0.99–2.69)	1.40 (0.77–2.57)	

IADL, instrumental activities of daily living; NH, nursing home
*ORs were estimated using a logistic regression model [model 2: Nagelkerke Pseudo R^2 = 0.315 (NH); 0.246 (community)].
†Model 1: Adjusted for sex and age (except for sex that was only adjusted for age and vice-versa); Model 2: Adjusted for variables in model 1 plus monthly income, self-reported health and symptoms of depression.
‡Participants with missing values for any of the independent variables were excluded from model 2.
§*P* for the interaction term, defined as independent variable in test × living setting.
‖Sample size (n) in the NH setting and (;) in the community setting for variables in model 1.
¶As to denote statistically significant results $P < 0.05$.

reported health is considered a general indicator of adverse health outcomes, and there is some evidence that it is a determinant of malnutrition [21,23]. In fact, acute or chronic disease-associated mechanisms (inflammatory or other) are recognized as important etiological factors for malnutrition [16]. Regarding depression, there is conflicting evidence about its association with malnutrition. On the one hand, longitudinal studies have found no association between the two [19,22,23,47]. On the other hand, depression has been associated with weight loss and poor appetite, which could decrease food intake and contribute to a worse nutritional status [47,52]. In fact, the instrument used here to assess nutritional status (MNA) assumes that psychologically impaired individuals (i.e., those with severe dementia or depression) have a worse nutritional status and thus, they score 0 points in MNA item E ("Neuropsychological problems"). However, there is evidence for different pathways linking depression and nutritional status after taking other variables into account (e.g., sex, age, pleasure of eating), which reveals the intricate nature of this association [52].

Lastly, interactions were tested for all variables under study because there is evidence, although not consensual, for the association between each of them and living setting [53]. Except for physical activity, no interactions were found between demographic, socioeconomic, health-related, and psychosocial variables and living setting. This result points out that, in the present sample, living setting did not modify the association between each studied factor and malnutrition. On the contrary, the setting changed the association between physical activity and malnutrition, possibly because NH residents were more dependent and less physically active than community dwellers.

Inevitably, this study had some potential limitations. First, except for anthropometric measures and some MNA items (based on clinical judgment), data relied exclusively on self-reported answers. This fact can introduce some bias, as it depends on participants' memories and personal interpretations, which may be especially relevant in the case of the oldest old. To minimize this bias, individuals with dementia were excluded and those with cognitive impairment did not answer all questionnaires. Additionally, bedridden individuals were excluded, and those severely ill or not able to answer a long survey were more likely to decline participation. The hypothesis that respondents might be healthier than non-respondents should be taken into account, even more considering the low participation rate among community dwellers. Moreover, individuals with cognitive impairment were excluded from the logistic models once they did not answer the full interview.

Combined, these methodological features probably affected the results, as there is evidence that worse mental and physical health is associated with worse nutritional status [15,23]. For some participants, it was not possible to measure height, and in these cases hand length was used to estimate it. Despite measured and predicted heights being strongly correlated for white adults, there are small mean differences between the two that might introduce some deviation to the BMI calculations herein. Also, the cross-sectional design did not allow us to draw conclusions about causal relationships and the direction of the associations.

Despite the aforementioned, the present study had some strengths and unique characteristics. It included a large, national representative sample, with individuals from both urban and rural areas, and it covers the wide age spectrum of people >65 y old. Also, MNA was used to assess the nutritional status, which allowed comparisons with international studies, as it is the most widely used instrument. Finally, the association between the living setting and malnutrition described here took into consideration a set of adjustment variables, such as demographic and socioeconomic characteristics, as well as physical and mental health-related factors.

Conclusions

The findings from this study embody the evidence that socioeconomic and health characteristics are associated with the nutritional status of older adults, independently of living in the community or in an NH. In the latter, it is crucial that staff members become aware of this, and that adequate resources are available to intervene both in nutrition and nutritional status' determinants. In the community, sufficient support should be provided to older individuals and their caregivers to maintain their functional ability for a daily independent life, as this appears to be a key factor to healthier and meaningful old years. Home-delivered care in articulation with primary health care would probably allow the vast majority of the older population to stay at home, not needing to move in to institutions and receive round-the-clock formal care. These conclusions call for both local and national level aging policies, some of which are already in the pipeline, like the national strategy on healthy aging. Future programs to improve nutritional status of older adults should address, not only food intake, but also functional status and mental health, particularly symptoms of depression and loneliness.

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Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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