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Nutritional risk and depression in adults over 60 years old

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Abstract.
BACKGROUND: The literature suggests that nutritional status is associated with the onset and maintenance of depressive symptoms, but the association is still unclear.
OBJECTIVES: Describe the association between malnutrition and depressive disorder.
METHODS: Cross-sectional study, in 221 non-randomly selected, community dwelling, individuals. Data were collected through individual, face-to-face interviews, which included questions on health, nutritional status, sociodemographic characteristics, and the interviewer versions of the Mini Nutritional Assessment and the Geriatric Depression Scale. Statistical analyses were conducted using IBM SPSS Statistics 27.0, and statistical significance for all procedures was set at 0.05.
RESULTS: The most prevalent clinical feature was pain during the last month (73.3%). 58 participants (26.2%) were at risk for malnutrition and 2 participants (0.9%) presented malnutrition. Depression was more prevalent in women (55.3%) than in men (37.5%). Odds to exhibit depression are 1.83 times higher (95% CI 1.16–3.68, $p = 0.036$) with malnutrition and 2.45 times higher (95% CI 1.25–4.78, $p = 0.009$) if reporting pain.
CONCLUSIONS: Clinicians should consider the assessment and intervention for both depression and malnutrition when encountering one of these conditions. Acute pain seems to have a strong association with depression and must also be addressed and considered in this regard.

Keywords: Depression, malnutrition, MNA, geriatric depression scale

1. Introduction

Depression can be defined as a major depressive disorder of multietiological nature, characterized by depressed mood and loss of interest or pleasure [1]. Is has been increasingly associated with disability and mortality, and it's considered a highly prevalent disease [2]. Worldwide estimates range from 3 to 10% for 12-month prevalence [3], and 12 to 21% for lifetime prevalence [4, 5].

A multinational European study estimates the 12-month prevalence for Portugal at around 7% [3] and cross-sectional data from a longitudinal population-based study, collected between 2013 and 2015 in a representative cohort of Portuguese seniors (≥65 years old), estimated the prevalence in this population as 11.8% [6].

An increased attention has recently been given to depression in older adults. Although there is evidence that the prevalence of major depressive disorders has an inverse association with age, depression in older adults is recognized as a serious public health problem [2, 7, 8] due to the fact that depression, in adults over 65-years old, is associated with increased comorbidity, impaired functioning, excessive use of health care resources, and mortality [7]. Older adults also have a higher prevalence of chronic illness, and the scientific literature reports an increased risk for depression and poorer long-term outcomes among people with chronic disease [7, 9]. Dementia,

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cerebrovascular disease, and multiple sclerosis have associations with depressive disorder, as well as other illnesses not associated with the central nervous system, such as cancer (particularly pancreatic, head and neck, and breast cancer), diabetes mellitus, autoimmune disorders, and coronary heart disease [4–6]. Depression appears to be both a risk factor and a predictor of increased mortality in patients with heart disease [10]. Additionally, demographic and social characteristics, such as low economic status, retirement, social isolation, and bereavement are related to depression in the elderly [11].

Major depressive disorder in elderly patients can result in decreased appetite and sleep, and can be a risk factor for involuntary weight loss and malnutrition [12]. On the other hand, malnutrition in the elderly may be caused by disfagia, gastrointestinal disorders, loss of taste or smell, and other conditions associated both with the physiological challenges of aging and with the highly prevalent chronic illnesses in this population [8, 9, 13].

Depressive disorder and malnutrition coexist in elderly populations and cross-sectional studies in Portugal reflect these findings [9, 14]. The PEN-3 S study reports a prevalence for risk of malnutrion of 16.4% (95% CI between 13.3% and 19.9%) coexisting with a prevalence of 23.5% (95% CI between 19.7% and 27.7%) for symptoms of depression. Both malnutrition and depression symptoms were higher in women and in older participants ($\geq$85 years old) [14]. This link between malnutrition and depressive disorder has been established in the literature, but its full description has yet to be made. The evidence shows a possible role of depressive symptoms as a predictor of malnutrition in community living elderly [15, 16], but some studies show similarities in malnutrition scores in individuals with and without depression [12, 17, 18].

There is no well-established theory that explains the complete pathogenesis of major depressive disorder. Studies on genetics, neurological determinants, neuroinflammation, neuroendocrinology, and other fields of research, in both humans and animal models, resulted in the proposal of several etiologic processes and in the development of pharmacologic and non-pharmacologic treatments, but, nevertheless, there are still many gaps in the knowledge about risk factors and causal pathways for depression [19, 20].

The literature suggests that nutritional status and the intake (or deficient intake) of some dietary components are associated with the onset and maintenance of depressive symptoms [21, 22]. Nutrients influence the brain's immune, antioxidant defence, and this can modulate the risk of depression. Several literature reviews [23–25] and reports of original research [22, 26, 27] show that micronutrient deficiencies may increase the risk of developing depressive disorder, and that micronutrient supplementation, mainly zinc, magnesium, and selenium, can be considered as an adjunct to antidepressant therapy.

A 2017 meta-analysis of observational studies [24] reports that adequate, high-quality dietary patterns, such as the Mediterranean diet or patterns that prevent inflammation, composed by a frequent intake of vegetables and pulses, with low added sugars and moderate amounts of animal products, have the potential to decrease the risk of depression by 36% when compared with more unhealthy diets. In longitudinal studies, intakes of sweetened beverages, processed meat, refined grain, and food with high fat contents have been associated with an increased risk of depression [23, 26]. Intakes of magnesium, calcium, iron, and zinc are reported as being inversely associated with the prevalence of depressive symptoms. Intakes of fish and vegetables are associated with lower depression risk, although not in a linear dose-response pattern [23, 24, 26].

The current demographic phenomenon of a progressively ageing population makes the identification of predictors and signs of depression in older adults increasingly important. Thus, this study aimed to describe the association between malnutrition and risk of depressive disorder, and to analyse malnutrition as a potential determinant of depressive disorder.

2. Methods

We conducted a cross-sectional, observational study, in a non-random sample of participants recruited through invitation sent to formal (non-governmental, non-lucrative associations of pensioners) and informal groups (such as book clubs or gardening clubs) of elders, municipalities, and other institutions with services aimed at individuals aged 60 years or above, in the region of Algarve, Portugal.

This study aimed to assess independent and autonomous community-dwelling elders and, as such, a sampling frame of individuals or of clusters of elders was not available. Thus, we proceeded to divulge our study using all communication channels available in our affiliate institution, in order to con-

struct a diverse, non-random sample, composed by all elders complying with the inclusion criteria. A set timeframe of two months was defined as the data collection phase and all of the replies and contacts received during that period resulted in invitations to be a part of the study.

Inclusion criteria were: 1) age above 60 years old; 2) independence and autonomy in daily life activities. Exclusion criterion was: cognitive impairment that made proper data collection impossible.

2.1. Data collection procedures

Data were collected through individual, face-to-face interviews. This data collection method was preferred, as it was to be expected that some potential participants would have low-literacy, could not read or write, or have sight impairments making the fulfilment of questionnaires impractical. Interviews here held at the University of Algarve, scheduled according to the participants availability, and lasted between 30 to 60 minutes.

The interview included questions on health problems, nutritional status, and sociodemographic characteristics. It also included the interviewer versions of the Mini Nutritional Assessment (MNA) and the Geriatric Depression Scale (GDS).

The MNA is a validated nutrition screening and assessment tool that can identify older adults who are malnourished or at risk of malnutrition. The maximum score is 30 points with cut-off limits set at 24 points ($\geq$24: well nourished) and at 17 points (17–23.5: at risk of undernutrition; <17: undernourished) [28].

The GDS is a public-domain tool used for depression screening [29]. The current study uses a validated short version, composed by 15 items, validated for the Portuguese population [30]. Each item is answered dichotomously ("Yes" or "No") and answers suggestive of depression are scored with 1 point. The final score corresponds to the sum of the scores for each question and can be classified into one of two categories: 1) results not suggestive of depression ($\leq$5 points); and 2) results suggestive of depression (>5 points).

Data on nutritional status also included the computation of the Body Mass Index (BMI) which was categorized with specific cut-points for elders [31]. Participants were categorized as underweight (<23 kg/m^2), normal weight ($\geq$23 to 30.9 kg/m^2) and overweight ($\geq$31 kg/m^2) [32].

Sociodemographic information included gender, marital status, and educational level. Health and clinical data were self-reported, and we did not have access to any medical or clinical records.

The study was approved by an Ethics Committee and all mandates of the Oviedo Convention and of the Declaration of Helsinki were strictly followed. A formal written consent was obtained from each participant before the data collection phase and all data protection regulations were observed.

2.2. Statistical analysis

Data were described using absolute and relative frequencies, mean (*M*), median (*Mdn*), standard deviation (*SD*) and interquartile range (*IQR*). We used the Kolmogorov-Smirnov test to assess adherence to the normal distribution. All variables in our study were either categorical or with a non-normal distribution. Thus, group comparisons were made using Kruskal-Wallis, chi-square, and Mann-Whitney's tests; correlations were computed using Spearman's correlation coefficient. When the results of the chi-square test were considered non-valid due to low expected frequency count, Fisher's or Fisher-Freeman-Halton's exact tests were computed.

To assess possible determinants of depression, we performed univariate analysis through binary logistic regression to identify associations between independent variables (non-communicable chronic diseases, lifestyle, and sociodemographic characteristics with a previously documented association with depression) and the possible outcome of the GDS (results not suggestive of depression and results suggestive of depression). We used variables with at least 15 valid cases in each category as predictors, as recommended by some authors [33, 34]. Variables with statistical significance in univariate analyses were included into a multivariable logistic regression model.

Statistical significance for all procedures was set at 0.05. All analyses were done using IBM SPSS Statistics 27.0.

3. Results

3.1. Sociodemographic and clinical characteristics

We assessed 221 participants, 74.7% females (n = 165) and 25.3% males (n = 56). Age ranged between 62 and 102 years old, without signifi-

Table 1
Sociodemographic and clinical characteristics for all participants and by gender

Characteristics	Total sample ($n=221$)		Females ($n=165$)		Males ($n=56$)		p-value
Age (years) mean (±*SD*)	79.6	(±8.8)	79.4	(±8.6)	80.2	(±9.4)	
Median (*IQR*)	78.0	(13.0)	78.0	(12)	81.0	(14)	0.447[a]
Marital status:							
Single; *n* (%)	5	(2.3%)	2	(1.2%)	3	(5.4%)	
Married/living together; *n* (%)	99	(44.8%)	59	(35.8%)	40	(71.4%)	
Divorced; *n* (%)	20	(9.0%)	18	(10.9%)	2	(3.6%)	
Widowed; *n* (%)	97	(43.9%)	86	(52.1%)	11	(19.6%)	**<0.001**[b]
Lives with:							
Spouse; *n* (%)	78	(35.3%)	46	(27.9%)	32	(57.1%)	
Family members; *n* (%)	30	(13.6%)	28	(17.0%)	2	(3.6%)	
Spouse and child(s); *n* (%)	8	(3.6%)	7	(4.2%)	1	(1.8%)	
Alone; *n* (%)	80	(36.2%)	67	(40.6%)	13	(23.2%)	**0.019**[b]
In an institution; *n* (%)	25	(11.3%)	17	(10.3%)	8	(14.3%)	
Provides daily care to:							
Parent; *n* (%)	3	(1.4%)	3	(1.8%)	0	(0%)	
Child; *n* (%)	5	(2.3%)	5	(3.0%)	0	(0%)	
Other; *n* (%)	20	(9%)	18	(10.9%)	2	(3.6%)	
Not a carer; *n* (%)	193	(86.3%)	140	(84.8%)	53	(94.6%)	0.057[b]
Schooling (years):							
Mean (*SD*)	5.11	(±3.7)	5.0	(±3.7)	5.3	(±3.7)	
Median (*IQR*)	4.0	(0)	4	(0)	4	(1)	0.462[a]
Schooling (level):							
Without formal schooling; *n* (%)	19	(8.6%)	15	(9.1%)	4	(7.1%)	0.727[c]
Incomplete primary school; *n* (%)	31	(14.0%)	25	(15.2%)	6	(10.7%)	
Primary school (4 years); *n* (%)	118	(53.4%)	86	(52.1%)	32	(57.1%)	
Middle school (5–9 years); *n* (%)	28	(12.7%)	21	(12.7%)	7	(12.5%)	
High school (10–12 years); *n* (%)	10	(4.5%)	7	(4.2%)	3	(5.4%)	
College level degree or equivalent; *n* (%)	15	(6.8%)	11	(6.7%)	4	(7.1%)	
Clinical characteristics:							
Hypertension; *n* (%)	119	(53.8%)	88	(53.3%)	31	(55.4%)	0.826
Dyslipidaemia; *n* (%)	86	(38.9%)	66	(40.0%)	20	(35.7%)	0.549
Loss of eyesight; *n* (%)	126	(57.0%)	96	(58.2%)	30	(53.6%)	0.637
Hearing loss; *n* (%)	147	(66.5%)	116	(70.3%)	31	(55.4%)	**0.030**
Cancer; *n* (%)	21	(9.5%)	13	(7.9%)	8	(14.3%)	0.158 [f]
Osteoarthrosis; *n* (%)	89	(40.3%)	76	(46.1%)	13	(23.2%)	**0.002**
Osteoporosis; *n* (%)	48	(21.7%)	47	(28.5%)	1	(1.8%)	**<0.001**
Type 2 diabetes *mellitus*; *n* (%)	51	(23.1%)	34	(20.6%)	17	(30.4%)	0.117
Thyroid disease; *n* (%)	24	(10.9%)	23	(13.9%)	1	(1.8%)	**0.012** [f]
Felt pain in the last month; *n* (%)	162	(73.3%)	126	(76.4%)	36	(64.3%)	0.077

SD – standard deviation; *IQR* – interquartile range. Gender differences computed with: [a] – Mann-Whitney's test; [b] – chi-square test; [c] – Fisher-Freeman-Halton exact test; [f] – Fisher's exact test. Statistical significance ($p<0.05$) is **boldfaced.**

cant gender differences ($p=0.447$). Table 1 shows sociodemographic and clinical variables.

Females had a higher prevalence of being widowed ($p<0.001$) and of living alone ($p=0.019$) than men. Around 13% of participants ($n=28$) provided daily care to a spouse, family member, or someone else. This variable did not show significant gender differences ($p=0.057$).

Educational level was moderate, with only 24% ($n=53$) of participants reporting more than 4 years of formal schooling. This result was statistically similar between genders (Fisher-Freeman-Halton exact test, $p=0.727$). Using Mann-Whitney's test to assess differences in years of schooling, we also did not find significant differences between genders ($p=0.462$).

The most prevalent clinical feature was feeling pain in at least one moment during the last month (73.3%). Loss of eyesight (57%) and hearing loss (66.5%) were also common.

Women had higher prevalence of hearing loss ($p=0.03$), osteoarthrosis ($p=0.002$), osteoporosis ($p<0.001$), and thyroid disease ($p=0.012$). 9.5% or

Table 2
Nutritional status for all participants and by gender

Characteristics	Total sample ($n = 221$)		Females ($n = 165$)		Males ($n = 56$)		p-value
BMI (kg/m^2) mean (±*SD*)	27.8	(±4.85)	27.9	(±5.0)	27.5	(±4.5)	
Median (*IQR*)	26.8	(6.5)	27.2	(6.6)	25.9	(6.5)	0.442[a]
BMI classification:							
Underweight; *n* (%)	29	(13.1%)	24	(14.5%)	5	(8.9%)	0.530[b]
Normal weight; *n* (%)	132	(59.7%)	96	(58.2%)	36	(64.3%)	
Overweight; *n* (%)	60	(27.1%)	45	(27.3%)	15	(26.8%)	
MNA classification:							
Well-nourished; *n* (%)	151	(72.9%)	115	(69.7%)	46	(82.1%)	0.167[b]
Risk for malnutrition; *n* (%)	58	(26.2%)	48	(29.1%)	10	(17.9%)	
Malnutrition; *n* (%)	2	(0.9%)	2	(1.2%)	0	(0%)	
MNA score:							
Mean (*SD*)	25.6	(±7.14)	24.9	(±2.60)	27.7	(±13.3)	
Median (*IQR*)	25	(3.5)	25	(3.5)	26.25	(3.25)	**0.002**[a]
Geriatic Depression Scale score:							
Mean (±*SD*)	5.6	(±3.1)	6.0	(±3.0)	4.6	(±2.9)	**0.006**[a]
Median (*IQR*)	5	(5)	6	(4)	5	(5)	
Geriatic Depression Scale results:							
Not suggestive of depression; *n* (%)	112	(50.7%)	77	(46.7%)	35	(62.5%)	**0.041**[b]
Suggestive of depression; *n* (%)	109	(49.3%)	88	(53.3%)	21	(37.5%)	

SD – standard deviation; *IQR* – interquartile range. Gender differences computed with: [a] – Mann-Whitney's test; [b] – chi-square test. Statistical significance ($p < 0.05$) is **boldfaced.**

participants ($n = 21$) reported having cancer, but none were currently undergoing treatment. Time since the treatment ranged between 1 and 32 years, with a mean of 9.82 years ($SD = 11$ years) and median of 4 years.

3.2. Nutritional status and depression

Table 2 shows the BMI and both score and results for MNA and GDS.

59.7% of participants ($n = 132$) had normal weight, 27.1% ($n = 60$) were overweight and 13.1% ($n = 29$) were underweight, with no significant gender differences. The MNA classification identifies 58 participants (26.2%) at risk for malnutrition and 2 participants (0.9%) with malnutrition.

For brevity, data on MNA items is not shown, but participants with normal weight, overweight, or obese, report prevalences of 12.7% for diminishing food intake in the last three months, 29.1% for some degree of weight loss in the last three months, 25.5% for psychologic stress or acute illness in the last three months, 45.5% for polymedication, and 21.1% for less than three glasses of liquids (water, tea, juice, etc.) a day.

We found a higher prevalence of depression in women (55.3%) than in men (37.5%), both when analysing results with GDS classification ($\chi^2_{(1)} = 4.19$, $p = 0.041$) or with GDS score ($p = 0.006$).

We found a negative, statistically significant, correlation between participants' scores in GDS and MNA ($r_{Spearman} = -0.219$, $p < 0.001$). According to the literature [35], this correlation can be considered of low strength ($0.1 < |r| < 0.3$), but the results are indicative of a higher degree of depression in participants with poorer nutritional status (higher scores in the MNA scale are suggestive of better nutritional status).

3.3. Determinants of depression

A binary logistic regression was performed to ascertain the effects of sociodemographic and clinical variables in this study on the likelihood that participants can be classified as having some degree of depression. Table 3 shows the results of the univariate analysis and the multivariable model.

The univariate analysis showed that having some degree of malnutrition ($OR = 2.41$, 95% CI 1.31–4.47, $p = 0.005$), being female ($OR = 1.9$, 95% CI 1.02–3.55, $p = 0.042$), having osteoporosis (OR = 2.92, 95% CI 1.55–5.51, $p < 0.001$), and having felt pain in the last month ($OR = 2.31$, 95% CI 1.19–4.49, $p = 0.014$), improve the likelihood of having depression.

Having been through the diagnosis and treatment for cancer, on the other hand, was identified as a variable that lowers the likelihood of depression

Table 3
Factors associated with Geriatric Depression Scale (GDS) results in all participants ($n = 221$)

	GDS results (suggestive of depression/not suggestive of depression)					
	Univariable logistic regression			Multivariable logistic regression		
	OR	95% CI	*p*-value	*OR*	95% CI	*p*-value
Some degree of malnutrition	2.41	1.31–4.47	**0.005**	1.83	1.16–3.68	**0.036**
Female	1.9	1.02–3.55	**0.042**	1.40	0.72–2.75	0.323
Carer	1.41	0.63–3.13	0.405			
Living alone	1.55	0.89–2.69	0.122			
Hypertension	1.3	0.76–2.21	0.333			
Dyslipidaemia	1.06	0.62–1.83	0.829			
Loss of eyesight	0.871	0.51–1.49	0.613			
Hearing loss	1.27	0.72–2.23	0.415			
Speech impediment	0.48	0.16–1.39	0.172			
Acid reflux	0.77	0.33–1.82	0.552			
Cancer	0.288	0.10–0.82	**0.019**			
Osteoarthrosis	0.77	0.45–1.32	0.338			
Osteoporosis	2.31	1.19–4.49	**0.014**	1.64	0.81–3.35	0.177
Type 2 diabetes	1.47	0.78–2.76	0.234			
Thyroid disease	1.26	0.54–2.94	0.598			
Felt pain in the last month	2.92	1.55–5.51	**<0.01**	2.45	1.25–4.78	**0.009**

OR – Odds ratio; CI – Confidence interval. Multivariable model: Hosmer & Lemeshow test for goodness-of-fit, $p = 0.441$; Model significance, $p < 0.001$; Nagelkerke $R^2 = 11.8\%$. Statistical significance ($p < 0.05$) is **boldfaced.**

(*OR* = 0.288, 95% CI 0.10–0.82, $p = 0.019$) and can be classified as a protective factor. This result prompts further study, but as this negative association is out of the scope of this paper, we did not include this variable in the multivariable logistic regression model. Thus, our multivariable analysis included only having some degree of malnutrition, being female, having osteoporosis, and having felt pain in the last month.

The logistic regression model was statistically significant ($\chi^2_{(3)} = 20.1$, $p < 0.001$). The model explained 11.8% (Nagelkerke R^2) of the variance in depression and correctly classified 64.24% of cases. Sensitivity was 52.8% and specificity was 77.7%. Of the four predictor variables, malnutrition and having felt pain were statistically significant: participants with malnutrition had 1.83 times higher odds to exhibit depression (95% CI 1.16–3.68, $p = 0.036$); participants that recently felt pain had 2.45 times higher odds to exhibit depression (95% CI 1.25–4.78, $p = 0.009$). Being female and having osteoporosis are associated with an increased likelihood of depression, but these variables do not contribute to the model in a statistically significant way.

Having pain in the last month seems a strong determinant of depression. Malnutrition is a weaker predictor, but our results suggest that it can play a role in depressive state.

The power of our model to predict the category of the participants in the dichotomous variable identifying depression was also ascertained by a ROC curve. Our results show an area under the ROC curve of 0.776 (95% CI, 0.705 to 0.848), which is an acceptable discrimination, according to the literature [36].

4. Discussion

Our sample, contrary to the evidence that shows that women are under-represented in health research [37, 38], has a significantly higher proportion of women. This can be the result of a selection bias due to the non-random nature of our sample, on account of the widespread recruitment efforts for the study, which may have been more visible in some community outreach organizations, such as those with more gendered-aimed activities or those aimed at elders affected by a specific illness (*e.g.*, associations of diabetes patients). Although these results may limit the external validity of our research, they do not hinder our ability to achieve the aim of the study.

We found a high prevalence of self-reported illnesses or conditions, which are not significantly dissimilar from the estimated prevalences for the region [39]. Prevalences for malnutrition (0.9%) and risk for malnutrition (26.2%) were also similar to the ones reported for Portuguese community dwelling individuals, which range between 0.7% and 2.1%

for malnutrition and between 18.1%, and 23.4% for malnutrition risk [40, 41].

Regarding depressive disorder, our study shows a high prevalence (49.3%) of participants with results suggestive of depression, significantly more frequent in women than in men (53.3% vs. 37.5%, $p = 0.041$). Although the gender differences found in our study are in concordance with the literature [42, 43], our results for prevalence are higher than those reported in recent studies in Portuguese elders, showing an overall prevalence of between 11.8% and 27.4% [6, 44, 45].

Our results suggest that having some degree of malnutrition, being female, having osteoporosis, and having felt pain in the last month improve the likelihood of depression. After inputting these variables in a regression model, the only significant predictors were having felt pain ($OR = 2.45$, 95% CI 1.25–4.78, $p = 0.009$) and having some degree of malnutrition ($OR = 1.83$, 95% CI 1.16–3.68, $p = 0.036$). Considering that, in our study, osteoporosis was significantly more prevalent in women ($p < 0.001$), there may be some confounding effect of gender in the association between osteoporosis and prevalence of depressive disorder.

Our results support an association between malnutrition and depressive disorder. There is a growing body of evidence suggesting that proper nutritional status, healthy dietary patterns, and specific dietary factors reduce the odds of depression, even when controlling for baseline characteristics and predictors of dietary exposure [46–50]. Some research suggests that the risk reduction is due to increased levels of specific nutrients, such as folate and vitamin B_{12} [51, 52], or that an increased depression risk can be the result of vitamin D deficiency [53–55] and low intake of long-chain omega-3 polyunsaturated fatty acids [56, 57]. Additionally, it's necessary to consider that poor nutrition is associated with the atrophic inflammation of the gastrointestinal tract that may occur with the aging process, leading to malabsorption and decreased appetite [50], and can also be the result of poor oral health or chewing problems in elders, following tooth loss, caries, and ill-fitting dentures [58].

One of the results in our logistic regression is contrary to the literature and prompts further study: having been through the diagnosis and treatment for cancer was recorded as lowering the likelihood of depression ($OR = 0.288$, 95% CI 0.10–0.82, $p = 0.019$). The literature suggests that cancer survivors experience late and/or long-term psychosocial and physical effects, even years after treatment ends [59], but this seems to be less common with advanced age [60]. Studies in cancer survivors aged 70 years or older show statistically similar prevalence of depressive disorder to the one recorded in the general population and, in cancer survivors, depression prevalence did not increase with older age [61–63]. There may be a psychosocial effect of surviving cancer, resulting from a different outlook on life which may be provided by the notion that after facing a life-threatening illness, individuals are more resilient and are more prone to enjoy some aspects of their daily life. These associations should be addressed in future studies.

Since our sample is not random, we have a limited ability to extrapolate our regression model to the general older adult population. The ability of our model to discriminate and detect individuals with depression, based on its sensitivity and specificity, is acceptable, but only explained 11.8% of the variance in DGS scores. This implies that other, more significant predictors, were not assessed in our analyses.

The present study had several limitations that must be acknowledged. The cross-sectional design and the observational nature of our work do not allow for proper causal relationship between depressive disorder and possible predictors to be established. Also, the self-report of clinical characteristics may have provided biased data regarding previous identification of conditions such as hypertension or hyperlipidaemia. There is also some concern regarding self-report scales for estimating the presence of depression. Despite widespread use and its documented validity, the GDS, in its version destined to be used in a face-to-face interview, can be susceptible to social desirability bias, as reported by the literature [64, 65].

Nevertheless, our work shows the complex interrelations between nutritional factors, clinical and sociodemographic characteristics, and depressive disorder in elders. Further studies, with follow-up and the ability to thoroughly assess exposure and dose-response effects, are needed.

5. Conclusions

Our results suggest that even in a community setting, malnutrition and risk of malnutrition can be a health issue that should be addressed. Also, depression appears to be widely prevalent and, thus, most

clinicians will encounter older patients with depression in their daily practice.

As depressive disorder seems to coexist with some form of malnutrition, we suggest that when dealing with elders with either depressive disorder or with malnutrition, clinicians should consider the assessment and intervention for both conditions. Pain seems to have a strong association with depression and must also be addressed and considered in this regard.

This study does not examine in detail the causal mechanism of depressive disorder, but our results reinforce the importance of a precise and early diagnosis of depression in the elderly.

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Conflict of interest

The authors have no conflict of interest to report.

Ethics statement

The study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Ethics Committee of the University of Algarve. Informed consent was obtained from all participants involved in the study.

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