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Cross-sectional study of the association between nutrition and depression in older people living in nursing homes

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Abstract

Background Cognitive dysfunction and depressive symptoms are common and closely related mental health issues in older people, significantly affecting their quality of life and social functioning. Nutritional factors play a key role in preventing and managing these conditions. This study aimed to examine the relationship between nutritional status and depressive symptoms and cognitive dysfunction in older people.

Methods Data from 126 participants aged 65 and older with chronic neurological disorders, recruited from nursing homes in Izmir, Turkey (January 2023-February 2023), were used in this cross-sectional study. The Geriatric Depression Scale (GDS)-30 and Mini Nutritional Assessment (MNA) were used to assess depression and malnutrition, respectively. Cognitive functions were evaluated using the Standardized Mini-Mental State Examination (SMMSE). Binary logistic regression analyses were performed to determine the risk of depression among malnourished people and to measure the risk of malnutrition among depressed people. Data collection was conducted prospectively through random, face-to-face interviews in nursing homes.

Results The average age of the participants in the study group was 77.05 ± 5.68 years, with a median age of 76.0 years. A statistically significant difference was observed between the median GDS score and the median age across MNA score categories ($p < 0.05$). The risk of malnutrition was roughly 10 times higher in patients with dementia (OR = 10.22, 95% CI: 4.33–24.11).

Conclusions The results show a strong association between depression and malnutrition in older people. Malnutrition is a common occurrence among older people, and age is a significant risk factor. Similarly, depression is more common among older people living in nursing homes, and increasing age also raises depression levels. Therefore, future research should focus on conducting randomized, double-blind, placebo-controlled trials to confirm the effectiveness of nutritional interventions and oral nutritional supplements in treating depression and improving cognitive function.

Keywords Malnutrition, Cognition, Depression, Older people, Aging, Nursing home, Health services

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Background

In neurological clinical practice, oral nutritional support products—known as oral nutritional supplements (ONS)—are commonly used. The use of ONS in acute and chronic neurological diseases (CND) has shown potential to influence clinical outcomes positively [1]. However, despite the high prevalence of neurological conditions and nutritional challenges in settings like nursing homes, where many older people live, there is a significant lack of research specifically focused on ONS use in these environments.

Neurological disorders, especially those requiring hospitalization, markedly increase the risk of malnutrition. This risk arises from various factors, including medical, physical, and social issues. Specifically, chronic neurological conditions that impair mobility—such as those seen in dementia progression—further amplify this risk. Malnutrition in older people is closely associated with the development of neuropsychiatric conditions, such as depression and delirium. Moreover, multiple studies have demonstrated that muscle loss, often linked to malnutrition, is connected to cognitive decline, physical disability, and depression in older people.

Age-related muscle loss is not solely caused by inadequate ONS intake but may also stem from a reduced anabolic response to stimuli such as amino acid (AA) supplementation. In this context, glutamine supplementation has been shown to support muscle hypertrophy through its anabolic effects [2, 3].

Depression among older people represents a growing public health issue, with recent studies showing a prevalence between 10% and 38% [4]. The bidirectional relationship between aging and nutrition complicates this problem. Aging often involves a decline in cognitive and physical abilities, which disrupts the balance between nutritional needs and intake, potentially creating a vicious cycle of depressive symptoms [5].

Multiple factors can lead to a decline in nutritional behavior among older people, including multimorbidity, polypharmacy, reduced senses of taste and smell, social isolation, and limited ability to access and prepare food. Together, these factors increase the risk of malnutrition in older people [6].

At the same time, physiological changes like decreased physical activity and muscle strength become more noticeable with aging, while the incidence of neurodegenerative diseases also increases [5, 6]. Nutrition and cognition are closely connected, showing a complex and evolving relationship. Experimental studies have shown that adequate nutrition may improve memory function. It is believed that this improvement could happen through vagal stimulation of the hippocampus by gastrointestinal hormones, such as cholecystokinin [7].

Although the causal relationships between cognitive decline, depression, and malnutrition are not completely understood, shared underlying mechanisms—including gut dysbiosis, oxidative stress, neuroinflammation, and mitochondrial dysfunction—have been suggested [8, 9]. Additionally, brain atrophy caused by neurodegeneration may affect hunger perception, swallowing, and eating behaviors. These changes can lead to malnutrition and cause alterations in neurotransmitter and neuroendocrine systems, thereby contributing to the onset or worsening of psychiatric conditions such as depression [10].

These interconnected processes may also influence allostasis, which is the body's active regulatory mechanism for adapting to environmental changes and maintaining homeostasis. Disruptions in allostatic pathways—especially those involving the hypothalamic-pituitary-adrenal (HPA) axis and brain-derived neurotrophic factor (BDNF)—can change the stress response and impact cognitive functions by altering glucocorticoid production and signaling pathways related to learning and memory [11].

This study aims to explore the connection between nutritional status, depressive symptoms, and cognitive impairment in older people. It also seeks to assess the impact of ONS in people with chronic neurological conditions.

Methods

Study design and patients

This cross-sectional study included 126 participants aged 65 and older living in three large nursing homes in Izmir, Turkey, between January 2023 and February 2023. Participants had no recent hospitalizations within the past month, no active infections or gastroenteritis at the time of the study, were not diagnosed with depression, and were not taking antidepressants. They also received only oral feeding. Patients who did not meet these criteria were excluded from the study.

Study size

This study tests the hypotheses regarding the relationships between nutritional status and two factors—depression and cognition—adjusting for various confounders such as age, ONS characteristics, Geriatric Depression Scale (GDS), and Standardized Mini-Mental State Examination (SMMSE) scores on three outcomes: malnutrition, depression, and cognitive dysfunction. Based on preliminary data from a pilot group, the effect sizes of nutrition (OR = 0.656) and depression (OR = 1.577) on cognition were observed to be small to moderate [12]. We conservatively assumed that the effect sizes of nutrition on depression and cognitive dysfunction were small to moderate (i.e., f2 = 0.02–0.15). The power analysis for the study was conducted using G*Power 3.1.9.2

(Universität Kiel, Germany) [13]. Assuming logistic multiple regression with several parameters (i.e., number of predictors = 3, power = 0.8, significance level = 0.05, f2 = 0.07), 110 subjects were needed for data analysis. Using a power (1−β) of 0.95 and an alpha level of 0.05, the minimum required sample size was calculated to be 110 patients. To account for potential dropout or missing data, the final sample size was increased by 15%, resulting in a total of 126 patients, as planned. This power analysis supports that the sample size is adequate to detect differences across diagnostic groups with small to moderate effect sizes.

The flow diagram of the study is shown in Fig. 1. Sixty-six of the participants were female (52.4%), and 60 were male (47.6%). The age range of the sample was from 65 to 90 years, with a mean age of 77.05 years (SD = 5.68). The sociodemographic characteristics of the participants are shown in Table 1.

Study data

Data collection was conducted prospectively in nursing homes through random face-to-face interviews with older people, meaning those who could be contacted during their stay at the nursing home and did not hinder

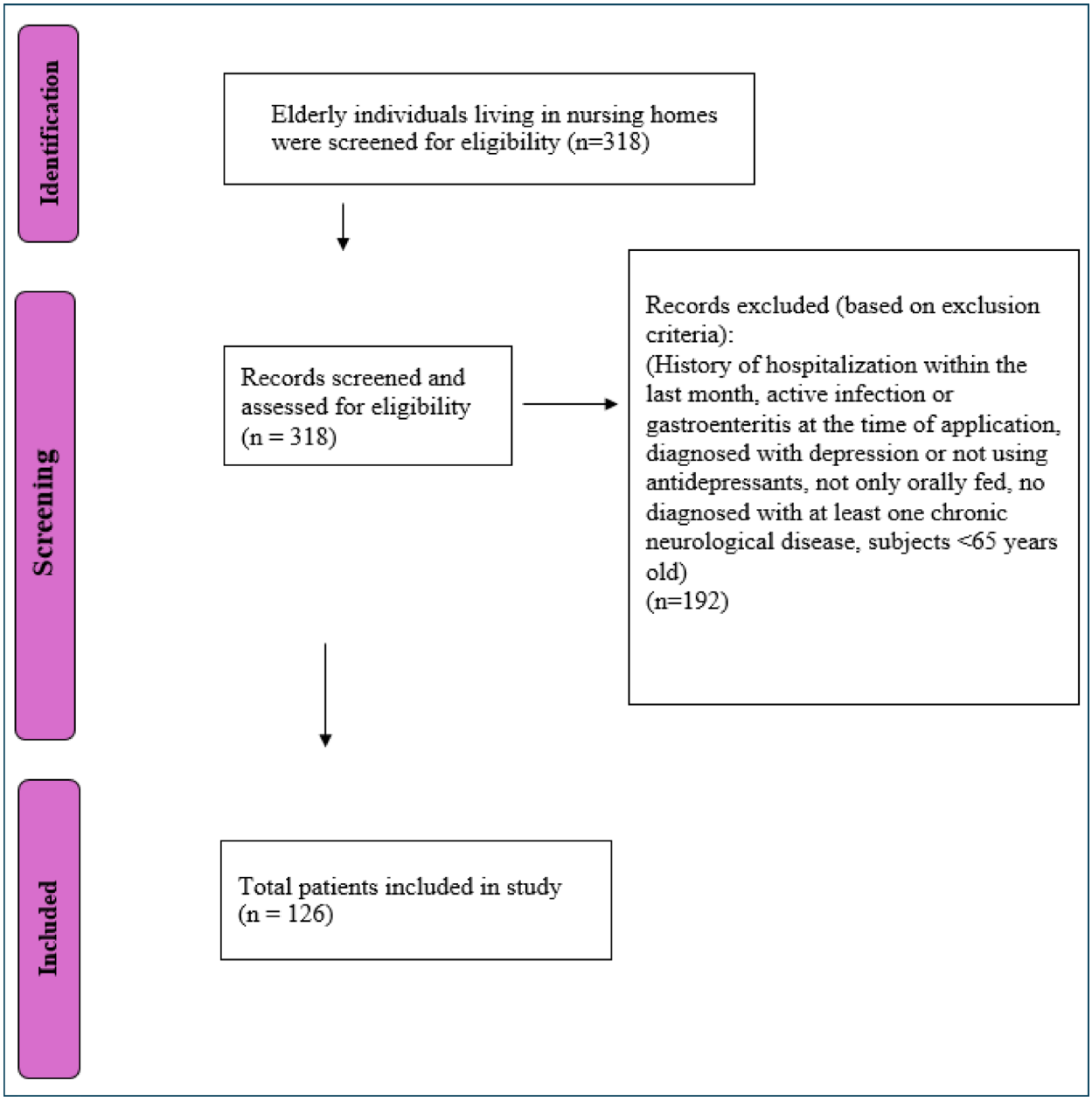

Fig. 1 Flowchart of the study 'It shows the inclusion scheme of the participants living in nursing homes within the framework of the exclusion criteria

Table 1 Distribution of patients included in the study according to chronic neurological disease groups

CND	*n*	%
Dementia	79	62.7
CVD	29	23
ALS	2	1.6
PD	14	11.1
MS	2	1.6
Total	126	100

CND chronic neurological disease, *ALS* amyotrophic lateral sclerosis, *PD* Parkinson's disease, *MS* multiple sclerosis, *CVD* cerebro-vascular disease

the study criteria, without following a specific order. Diagnostic information was obtained from medical documentation.

The data were collected through a questionnaire. It consisted of two parts. The first part gathered sociodemographic information and medical history, obtained via self-reports and medical records. The second part included questions assessing cognitive function, depression, and malnutrition.

Ethical issues

This study was conducted in accordance with the Declaration of Helsinki by the World Medical Association. It was approved by the İzmir Bakırçay University Non-Invasive Transactions Ethics Committee (approval No. 841, clinical trial No. 861, January 25, 2023). All participants signed informed consent forms.

Survey tools

The Geriatric Depression Scale (GDS-30) and Mini Nutritional Assessment (MNA) were used to evaluate depression and malnutrition, respectively.

The GDS is a tool used to screen older patients at risk of depression. It is suitable for healthy people, those with medical illnesses, and those with mild to moderate cognitive impairment [14]. The 30-item GDS was developed by Yesavage et al. (1982), and its validity and reliability have been assessed in Turkey by Ertan et al. (1997) [15, 16]. The main goal of this scale (GDS-30) is to include easy-to-answer questions for older people. When scoring this scale, which consists of questions with only "yes" or "no" answers, 1 point is awarded for each response indicating depression, and 0 points for all other answers; the total score represents the depression score. The sensitivity and specificity of this 30-question version were found to be 80% and 100%, respectively, when the cutoff point was set at 14. A score of 0–10 indicates no depression or normal, 11–13 suggests "probable (mild) depression," and 14 or higher indicates "definite depression" [16].

The MNA is a tool used to identify patients at risk of malnutrition. It functions as both a screening and an assessment tool for detecting malnutrition in older people [17]. MNA-Short Form (MNA-SF): The MNA-SF is a screening tool used to identify older people (>65 years) who are malnourished or at risk of malnutrition. The MNA-SF was last updated in 2009 [18]. Its validity and reliability within Turkey were evaluated by Sarikaya et al. in 2013 [19]. The MNA-SF begins with six screening questions, and the total score on the scale ranges from 0 to 14. A total score of 12–14 indicates "normal nutritional status," 8–11 indicates "malnutrition risk," and 0–7 signifies "malnutrition."

Cognitive functions were evaluated using the Turkish version of the SMMSE, administered by trained clinical psychologists [20]. Written permission to use the SMMSE in our manuscript has been obtained from Dr. D. William Molloy, the full copyright holder of the instrument (contact: w.molloy@ucc.ie).

A score below 25 indicates cognitive impairment, and older people with Alzheimer's disease (AD) were divided into three subgroups based on their SMMSE scores: mild AD (SMMSE < 25 and > 18), moderate (SMMSE ≤ 18 and > 10), and severe AD (SMMSE ≤ 10) [21]. Participants with SMMSE scores ≤ 10 were excluded from depression-related analyses using the GDS to reduce measurement bias caused by limited cognitive ability.

A rating scale was not used to determine the level of physical activity in this study. One key reason is that the study focused on a more specific group with strict limitations. Since physical limitations are common among older people living in nursing homes and with CND, it was believed that physical activity scales might not be sensitive enough to assess depression, cognition, and malnutrition. However, inactivity was still analyzed as an independent variable in this process.

To address potential confounding by indication, glutamine supplementation was excluded from the primary logistic regression model predicting malnutrition (MNA ≤ 11). A separate exploratory model was developed to examine the association between glutamine use and depressive symptoms (GDS ≥ 11).

Statistical analysis

Descriptive statistics were obtained to provide the frequency and percentages of categorical data, as well as the mean and standard deviation values of continuous data. The chi-square (χ^2) test was used to assess relationships within categorical data. Normality of continuous data was tested using the Kolmogorov-Smirnov test, and the Kruskal–Wallis test was employed to compare medians. The ROC curve analyzed new cut-off values on the GDS and MNA scales. For scale evaluation, binary logistic regression analyses were performed to measure the risk of depression in malnourished people and the risk of malnutrition in depressed people. All analyses were conducted using SPSS (v26, IBM) at a significance level of $\alpha = 0.05$.

Results

Descriptive and scale assessment data

Most patients in the study were diagnosed with dementia (62.7%). In addition to dementia, the CND groups also included patients with cerebrovascular disease (CVD), Parkinson's disease, amyotrophic lateral sclerosis (ALS), and multiple sclerosis (MS). The distribution of patients across the CND groups is shown in Table 1.

The distribution of malnutrition (MNA) and depression (GDS) scales among older people, based on their scores, was analyzed using descriptive statistics (Tables 2 and 3). These tables also examine the categorical status of both scales. The overall gender distribution shows similar patterns on both scales. The first key finding is that the percentage of women (52.4%) exceeds that of men (47.6%) among the participants. In the distribution of participants according to their scores on the MNA scale, most older people (84.5%) showed signs of malnutrition across all categories. It was found that age and GDS scores do not follow a normal distribution, as indicated by the Kolmogorov- Smirnov test ($p < 0.05$). As a result, a statistically significant difference was observed with 95% confidence using the Kruskal- Wallis test, which assessed differences in GDS scores across MNA score categories by age ($p < 0.05$). It was also noted that the risk of malnutrition increases with age (Fig. 2a). Additionally, malnourished people tend to have higher GDS scores, and their MNA scores improve as depression symptoms decrease. The increase in GDS scores with age is illustrated in Fig. 2b. The average GDS score for malnourished people (Mean = 21. 21.07, SD = 1. 94) was significantly higher than for those with normal nutritional status (Mean = 8. 21, SD = 3. 08) and those at risk of malnutrition (Mean = 14. 31, SD = 3. 07) (Fig. 3). The χ^2 test, used to examine the relationship between MNA score categories and other variables, revealed a statistically significant correlation between nutritional status (MNA score) and factors such as CND, ONS, inactivity, glutamine, and SMMSE with 95% confidence ($p < 0.05$). This relationship was also observed in the categorical GDS- 11

Table 2 Subject characteristics according to nutritional status (Mean ± SD(Median) or f(%))

MNA (*n* = 126)					
Variable	**Normal (*n* = 58)**	**At risk (*n* = 54)**	**Malnourished (*n* = 14)**	**Total**	***p*-value**
Age	72.88 ± 3.51(74.0)	79.63 ± 4.47(80.5)	84.43 ± 3.37(84.5)	77.05 ± 5.68(76.0)	< 0.001
GDS_score	8.21 ± 3.08(8.0)	14.31 ± 3.07(14.0)	21.07 ± 1.94(21.0)	12.25 ± 5.18(11.0)	< 0.001
Gender					
Female	28(48.3)	31(57.4)	7(50.0)	66(52.4)	0.616
Male	30(51.7)	23(42.6)	7(50.0)	60(47.6)	
CND					
Demantia	21(36.2)	45(83.3)	13(92.9)	79(62.7)	< 0.001
Others	37(63.8)	9(16.7)	1(7.1)	47(37.3)	
ONS					
Present	1(1.7)	18(33.3)	10(71.4)	29(23.0)	< 0.001
Immobility					
Present	0(0)	13(24.1)	9(64.3)	22(17.5)	< 0.001
Glutamine					
Present	49(84.5)	53(98.1)	13(92.9)	115(91.3)	0.037
Hypertension					
Present	41(70.7)	37(68.5)	10(71.4)	88(69.8)	0.960
DM					
Present	20(34.5)	13(24.1)	3(21.4)	36(28.6)	0.391
Hyperlipidemia					
Present	14(24.1)	11(20.4)	2(14.3)	27(21.4)	0.700
GDS-11					
Normal	47(81.0)	5(9.3)	0(0)	52(41.3)	< 0.001
Mild + depressed	11(19.0)	49(90.7)	14(100.0)	74(58.7)	
SMMSE_c					
Light(> 19)	19	1	0	20	< 0.001
Mild + severe(≤ 18)	2	42	13	57	

p value is derived from either Kruskal Wallis or Chi-Square test

GDS gediatric depression scale, *MNA* mini nutritional assessment, *ONS* oral nutritional supplements, *CND* chronic neurological disease, *SMMSE* standardized mini-mental state examination, *SD* standart deviation, *f* frequency

Only the proportions of participants with the presence ("yes") of each binary variable are shown. "No" categories are omitted for clarity

Table 3 Subject characteristics according to depression symptom (Mean ± SD(Median) or f(%))

GDS(n = 126)					
Variable	**Normal (*n* = 52)**	**Mild (*n* = 25)**	**Depressed (*n* = 49)**	**Total**	***p*-value**
Age	73.46 ± 3.97(74.0)	77.32 ± 4.56(76.0)	80.73 ± 5.39(82.0)	77.05 ± 5.68(76.0)	< 0.001
Gender					
Female	27(51.9)	11(44.0)	28(57.1)	66(52.4)	0.562
Male	25(48.1)	14(56.0)	21(42.9)	60(47.6)	
CND					
Dementia	20(38.5)	17(68.0)	42(85.7)	79(62.7)	< 0.001
Others	32(61.5)	8(32.0)	7(14.3)	47(37.3)	
ONS					
Present	1(1.9)	6(24.0)	22(44.9)	29(23.0)	< 0.001
Immobility					
Present	1(1.9)	3(12.0)	18(36.7)	22(17.5)	< 0.001
Glutamine					
Present	44(84.6)	23(92.0)	48(98.0)	115(91.3)	0.059
Hypertension					
Present	34(65.4)	17(68.0)	37(75.5)	88(69.8)	0.528
DM					
Present	14(26.9)	5(20.0)	17(34.7)	36(28.6)	0.393
Hyperlipidemia					
Present	11(21.2)	4(16.0)	12(24.5)	27(21.4)	0.700
MNA					
12–14	47(90.4)	7(28.0)	4(8.2)	58(46.0)	< 0.001
8–11	5(9.6)	18(72.0)	31(63.3)	54(42.9)	
0–7	0(0)	0(0)	14(28.6)	14(11.1)	
MNA					
12–14	47(90.4)	7(28.0)	4(8.2)	58(46.0)	< 0.001
0–11	5(9.6)	18(72.0)	45(91.8)	68(54.0)	
SMMSE_c					
Light(> 19)	16	4	0	20	< 0.001
Mild + Severe(≤ 18)	4	13	40	57	

p value is derived from either Kruskal Wallis or Chi-Square test

GDS gediatric depression scale, *MNA* mini nutritional assessment, *ONS* oral nutritional supplements, *CND* chronic neurological disease, *SMMSE* standardized mini-mental state examination, *DM* diabetes mellitus, *SD* standart deviation

Only the proportions of participants with the presence ("yes") of each binary variable are shown. "No" categories are omitted for clarity

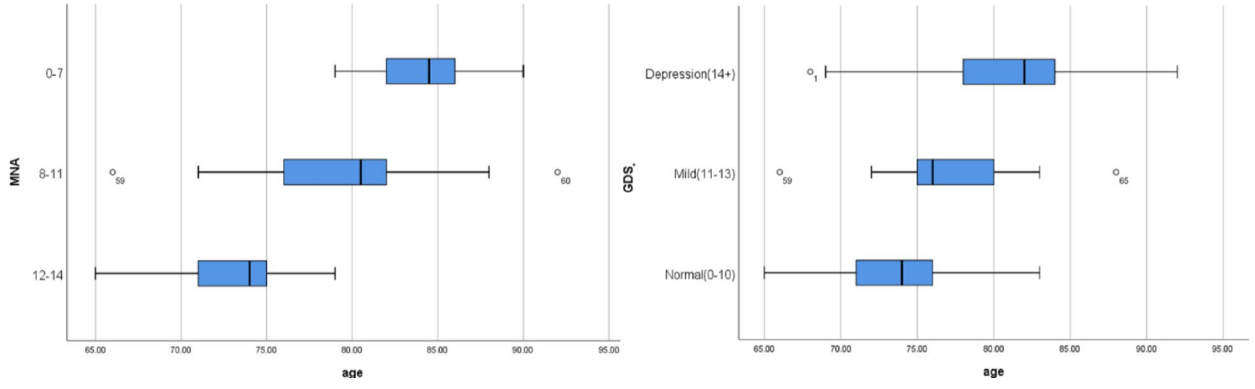

Fig. 2 **a** Boxplot of age by MNA. **b** Boxplot of age by GDS

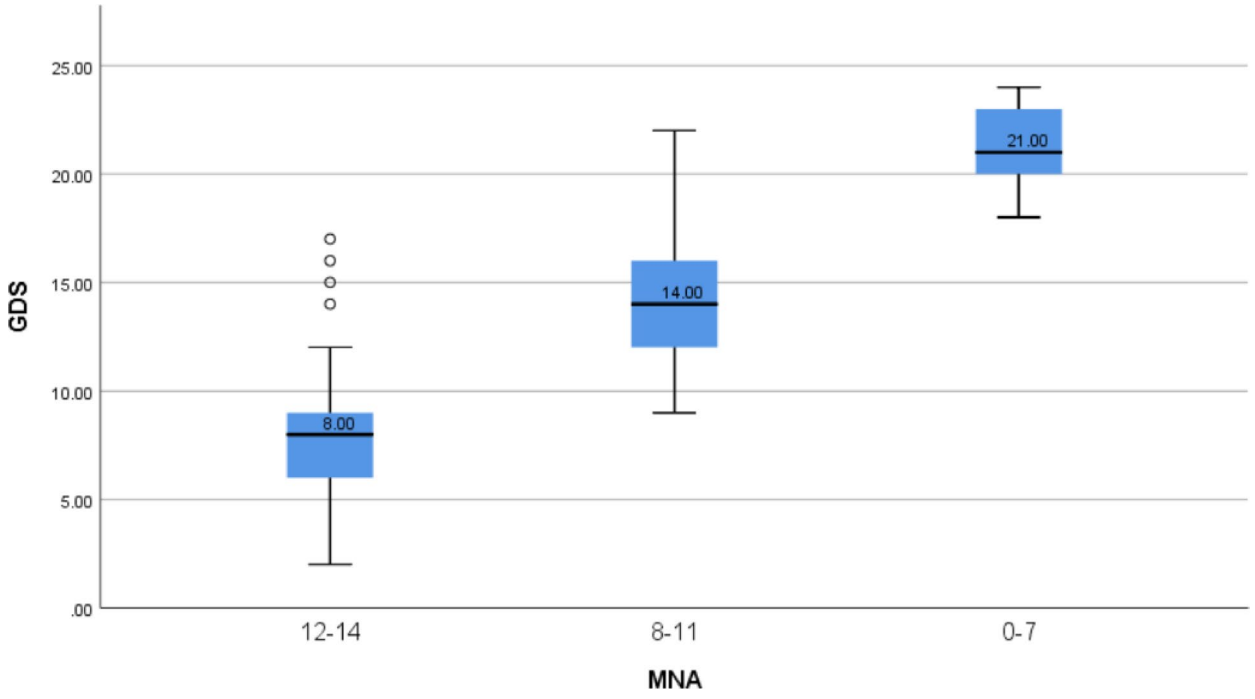

Fig. 3 Boxplot of GDS by MNA

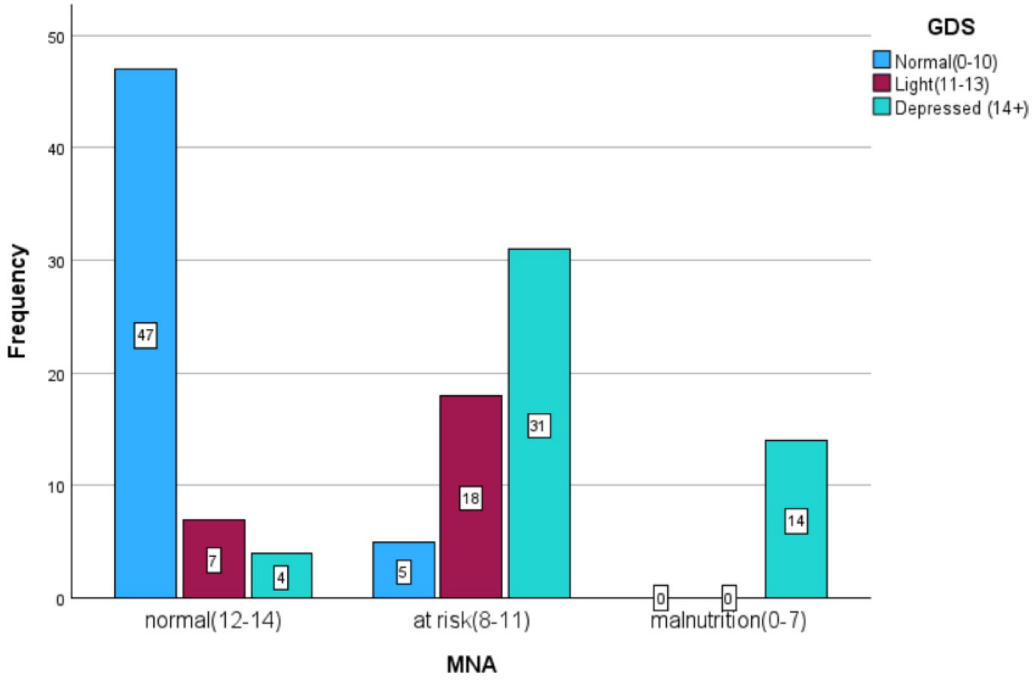

Fig. 4 A Scatter plot associated with MNA and GDS

scores. Finally, the prevalence of malnutrition was high across all significant variables (Table 2). Since SMMSE is a continuous variable, a scatter plot combining MNA and GDS scores could not be produced; however, a scatter plot relating MNA and GDS scores is shown in Fig. 4.

The distribution of older people based on GDS scale scores is shown in Table 2. The Kruskal-Wallis test, used to assess differences in age across GDS score categories, indicated a statistically significant difference with 95% confidence ($p < 0.05$). Additionally, 59% ($n = 74$) of the older people exhibited symptoms of depression. The average age (Mean = 82, SD = 5.39) was significantly higher in 66% ($n = 49$) of those with depression symptoms ($p < 0.001$), suggesting that depression levels tend

Table 4 Distribution of oral nutritional supplement (ONS) types among participants

ONS			
Valid	**Frequency**	**%**	**Valid %**
Standard	46	36.5	39
High calorie	28	22.2	23.7
High protein	6	4.8	5.1
Condition specific	17	13.5	14.4
Combine	21	16.7	17,8
Total	118	93.7	100
ONS free	8	6.3	
Total	126	100	

ONS oral nutritional supplements

to increase with age. The χ^2 test, used to examine the relationship between GDS score categories and other variables, found significant associations between nutritional status and variables such as CND, ONS, inactivity, MNA, and SMMSE, with 95% confidence ($p < 0.05$). It is reasonable to infer this relationship in the categorical form of MNA as well. Higher depression levels are associated with greater malnutrition. Conversely, no significant correlation was observed between variables such as glutamine, hypertension, DM, hyperlipidemia, and gender (Table 3). The two-sample t-test showed no significant difference in mean SMMSE scores between patients using glutamine and those not using it ($p = 0.581$, $\alpha = 0.05$).

Types of oral nutrition supplements

ONS are categorized into five types: standard supplements (36.5%), high-calorie supplements (22.2%), high-protein supplements (4.8%), supplements intended to support medical nutrition therapy for specific conditions (13.5%), and combinations of these (16.7%). Standard supplements deliver a variety of macro- and micronutrients that may be difficult to obtain through diet alone, while high-calorie supplements provide more energy-dense nutrition options. Formats include high-protein supplements that contain extra protein to support immune function and recovery from illness or injury, as well as disease-specific supplements tailored to particular patient groups, such as those with diabetes. The types of ONS used by patients in the study group, along with their percentage distribution, are shown in Table 4.

Logistic regression models

Some studies in the literature have performed binary logistic regression analysis for MNA and GDS scores by simplifying the number of categories to two [22, 23]. Based on the ROC curve analysis conducted for this study, new cut-off scores were identified for the GDS and MNA scales, considering the SMMSE score (area under the curve > 0.90). Consequently, the GDS score was categorized as "normal: 10 and below" and "slightly suppressed: 11 and above," while the MNA score was classified as "normal: 12 and above" and "malnutrition status: 11 and below."

Table 5 Logistic regression models for geriatric depression scale (GDS) and mini nutritional assessment (MNA)

GDS score					
Variable	**Normal**	**Mild + depressed**	**Chi-square**	***p*-value**	**OR (95% CI)**
MNA					
Normal	47	11	70.11	< 0.001	1 (Reference)
Malnutrition	5	63			53.84(17.52-165.43)
		MNA			
Variable	Normal	Malnutrition	Chi-Square	p-value	OR (95% CI)
CND					
Others	37	10	28.15	< 0.001	1 (Reference)
Dementia	21	58			10.22(4.33–24.11)
ONS					
Absent	57	40	12.60	< 0.001	1 (Reference)
Present	1	28			39.9(5.21-305.39)
Glutamine					
Absent	9	2	5.02	0.025	1 (Reference)
Present	49	66			6.06(1.25–29.31)
Age	58	68	31.28	< 0.001	1.62(8.51–82.02)

OR Odds ratio, *MNA* mini nutritional assessment, *ONS* oral nutritional supplements, *CND* chronic neurological disease, *GDS* gediatric depression scale, *OR* odds ratio, *CI* confidence interval

Two different logistic models were developed for dual GDS and MNA scores. In the first model for the GDS score, only the MNA score was included. Conversely, the model for the MNA score incorporated CND, ONS, glutamine, and age variables. The GDS logistic regression showed that the risk of depression was significantly higher in malnourished people (OR = 53.84, 95% CI = 17.52, 165.43) compared to those with normal nutrition. The MNA score model revealed that malnutrition risk was significantly greater in people with dementia and those using ONS and glutamine. The risk of malnutrition was approximately 10 times higher in dementia patients (OR = 10.22, 95% CI: 4.33–24.11), nearly 40 times higher in people who received ONS (OR = 39.9, 95% CI: 5.21-305.39), and about 6 times higher in those taking glutamine supplements (OR = 6.06, 95% CI: 1.25–29.31). Lastly, the risk of malnutrition increased with age (OR = 1.62, 95% CI: 1.08–2.42) (Table 5).

Supporting data

To account for potential confounding by indication, a sensitivity analysis was conducted using a multivariate logistic regression model limited to participants with SMMSE scores greater than 10. In this adjusted model, MNA scores remained a significant independent predictor of depression, while ONS use no longer held statistical significance. CND, glutamine supplementation, and age were also significantly associated with depressive symptoms (Table S1). These findings suggest that the strong association between ONS use and depression observed in the initial model may have been partly influenced by the participants' underlying clinical status.

A binary logistic regression model was used to identify predictors of malnutrition (MNA ≤ 11), excluding glutamine supplementation to minimize bias. The analysis showed that age, CND, ONS use, and immobility remained significant independent predictors (Table S2). Although glutamine was excluded due to heterogeneous dosing, an exploratory model suggested a significant association between glutamine use and higher GDS scores (Table S3).

According to study data, 17.5% of participants ($n = 22$) were classified as immobile, and this variable was included in the multivariate regression models as an independent predictor (Table S4).

Discussion

This study demonstrated a significant association between malnutrition and depressive symptoms in older people, in line with prior evidence suggesting that comorbid conditions markedly increase the risk of malnutrition [24–26]. Worsening nutritional status was notably associated with the presence of CND, immobility, higher GDS scores, and lower SMMSE scores. These results emphasize the complex, multifactorial causes of malnutrition in this population.

Although social determinants of nutrition were not evaluated, several studies have shown that nutritional status is closely linked to psychosocial well-being [27]. Additionally, a growing body of evidence supports the role of neuroinflammatory processes, mediated through the gut–brain–microbiota (GBM) axis, in the development of neuropsychiatric disorders, including depression [28–31].

Despite advances in understanding the biological pathways linking malnutrition and depression, correcting malnutrition through depression treatment alone remains limited in older people. This may be due to age-related physiological decline and the multifactorial nature of nutritional deficiencies. While one study reported that selective serotonin reuptake inhibitors (SSRIs) improved nutritional status and Mini Nutritional Assessment (MNA) scores in non-demented outpatients [32], these results may not be applicable to nursing home settings, where comorbid neurodegenerative conditions are more common.

Our data further indicate that depressive symptoms were more common among people who were fully dependent on ONS, even when their caloric intake was sufficient. Similar patterns were seen in those with immobility and CND, suggesting that functional dependence independently contributes to the coexistence of malnutrition and depression. Resistance training, designed to improve muscular strength through progressive overload, has been shown to provide benefits for cognitive and mental health when practiced regularly by older people [33]. Numerous studies have also found an inverse relationship between physical activity levels and depression [34–36]. However, in people with significant physical limitations, standard physical activity assessment tools may be insufficient [37]. For this reason, immobility was analyzed as a separate variable. Although standardized physical activity scales were not suitable due to cognitive and functional limitations, immobility was operationalized as a binary clinical indicator based on medical records, with 17.5% of participants classified as immobile, defined by being either bedridden or unable to walk independently. Future research should incorporate standardized mobility scales or structured functional assessments to understand better the impact of mobility on nutritional status and mental health.

The prevalence of malnutrition in our study population (84.5%) was higher than in most community-based studies but was similar to earlier findings in nursing home residents [38, 39]. For example, among 448 community-dwelling older people receiving outpatient care, the malnutrition rate was 17%, with a risk factor of 58% [23]. In our sample, mean GDS scores were notably higher in malnourished people compared to those with normal nutritional status or those at risk, consistent with previous research [22, 23, 40].

Multivariate analysis showed that the MNA score was the only independent predictor of the GDS score, while the MNA was significantly affected by age, CND, ONS use, and glutamine supplementation. Age was also significantly linked to GDS categories, supporting previous evidence of a direct relationship between age and depressive symptoms [26]. Although women (52.4%) outnumbered men (47.6%), no significant gender differences were found in GDS or MNA scores.

This study also showed that the severity of malnutrition grew along with depression scores. Depressive symptoms were also linked to several clinical factors, including CND, ONS use, immobility, nutritional status, and cognitive decline. Notably, only participants without a prior depression diagnosis or current antidepressant use were included. Although previous research suggests that

depression prevalence in nursing homes may be up to four times higher than among community-dwelling older people [41], the lower rate seen in our study may be due to the limited sensitivity of the GDS in older people with advanced cognitive impairment.

In our study, depressive symptoms were present in 75% of older people diagnosed with dementia. Among those with more severe cognitive impairment (SMMSE < 18), the prevalence rose to 93%, while 80% of participants with relatively preserved cognitive function (SMMSE > 19) did not show depressive symptoms. These rates are much higher than those found in a previous observational study conducted in a dementia-specific care setting, where depression prevalence ranged from 20 to 25% based on the CSDD [42]. The higher prevalence in our study may be due to the use of the GDS, which is known to have limited validity in people with advanced cognitive impairment, coupled with the broader clinical diversity found in a general nursing home population.

In our study, 57% of older people with dementia were at risk of malnutrition, and 16% were malnourished. Among those with SMMSE scores < 18, these rates increased to 74% and 23%, respectively. A previous outpatient study similarly reported low MNA scores in 77% of people with dementia and 63% of those with impaired cognition [22]. Current data indicate that dependent living conditions, such as residing in a nursing home, are associated with an increased risk of malnutrition in older people with dementia.

Given the extremely high odds ratio (OR = 39.9) observed for ONS use, the possibility of confounding by indication should be considered. Residents in poorer health or with greater functional decline may have been more likely to receive ONS, which could overestimate the association between ONS and depressive symptoms. To investigate this, a sensitivity analysis was performed excluding participants with severe cognitive impairment (SMMSE ≤ 10). In this analysis, ONS use was no longer a statistically significant predictor of depression, while MNA scores, age, glutamine use, and CND remained significant. This indicates that the relationship between ONS and GDS scores may be partly due to residents' underlying health status rather than a direct effect of ONS. These findings emphasize the importance of cautious interpretation of associations derived from cross-sectional data.

Despite the clinical importance of the findings, several limitations should be recognized. First, the relatively small sample size may have inflated specific odds ratios and limited the generalizability of the results. Additionally, the distribution of patients across CND subgroups was uneven—especially for ALS and MS—which may have decreased the statistical power to identify meaningful differences among diagnostic categories. The cross-sectional design of the study also prevents any conclusions about causality. Future longitudinal or interventional studies with larger and more diverse populations are needed to understand better the temporal and causal relationships among nutritional status, depressive symptoms, and cognitive impairment.

Furthermore, a significant limitation involves the lack of standardized dosing for glutamine and ONS. Since these interventions were prescribed based on people's clinical assessments rather than protocol-driven regimens, there was substantial variation in both dosage and duration. This variability may have affected the observed associations. To better understand potential dose–response relationships and enhance interpretability, future studies should adopt standardized or stratified supplementation protocols, ideally within the framework of randomized controlled trials. Importantly, sensitivity analysis excluding glutamine use confirmed the robustness of the primary model, with age, ONS use, cognitive impairment, and immobility remaining significant predictors of malnutrition in older people.

Additionally, the GDS may be suboptimal for assessing depression in participants with significant cognitive impairment; our analyses were limited to participants with SMMSE > 10. Future studies should employ additional scales, such as the CSDD, to improve understanding of the phenomenon. Although psychological assessments were conducted by clinic psychologists blinded to the study hypotheses, interactive administration may have introduced response bias due to age-related communication challenges.

Future directions

Future research should focus on randomized, double-blind, placebo-controlled trials to assess the effects of nutritional interventions and ONS on depressive symptoms and cognitive outcomes in older people. Including larger, more diverse populations and using validated assessment tools, neuroimaging methods, and molecular biomarkers will improve diagnostic accuracy. Additional studies exploring the GBM axis should combine animal models with human clinical data to deepen understanding. Molecular evaluations—such as hypothalamic-pituitary-adrenal (HPA) axis hormones, neuroinflammatory markers, and neurotrophic factors like brain-derived neurotrophic factor (BDNF)—may aid in developing objective, measurable metrics to guide clinical treatments [43–45].

Conclusion

The results indicate a strong association between depression and malnutrition in older people. Malnutrition is common among older people, and increasing age is a significant risk factor. Likewise, depression is more

prevalent in older people living in nursing homes, and aging also raises the level of depression. The cutoff score for depression and malnutrition was 14 in this study, consistent with existing research, and the connection between depression and malnutrition was powerful in the logistic regression models. Cognitive impairment increases the risk of both depression and malnutrition. More research is necessary to verify these results in larger, more diverse nursing home populations and through randomized, double-blind, placebo-controlled trials.

Supplementary Information

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Supplementary Material 1

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Author contributions
T.P. conceived this project, contributed to the acquisition of data, conducted data analysis, interpreted the data and drafted the first version of manuscript. N.B.O. contributed to interpretation of the data. All authors approved the definitive version of the manuscript.

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Data availability
The datasets used and/or analyzed during the present study are available from the corresponding author upon request.

Declarations

Ethics approval
Ethical approval for this study was obtained from the Institutional Ethics Committee of İzmir Bakırçay University (approval No. 841, clinical trial No. 861, January 25, 2023). Informed consent was obtained from all the participants and their legal guardians.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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