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FACTORS ASSOCIATED WITH POOR NUTRITIONAL STATUS AMONG COMMUNITY DWELLING LEBANESE ELDERLY SUBJECTS LIVING IN RURAL AREAS: RESULTS OF THE AMEL STUDY

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Abstract: *Objectives:* This study aimed to assess the nutritional status, measured by MNA, and its association with socio-demographic indicators and health related characteristics of a representative sample of community dwelling elderly subjects. *Design:* Cross-sectional study. *Setting:* Community dwelling elderly individuals living in rural communities in Lebanon. *Participants:* 1200 elderly individuals aged 65 years or more. *Measurements:* Socio-demographic indicators and health related characteristics were recorded during a standardized interview. Nutritional status was assessed through Mini Nutritional Assessment (MNA). The 5-item GDS score and the WHO-5-A score were used to assess mood, whereas Mini Mental Status (MMS) was applied to evaluate cognitive status. *Results:* The prevalence of malnutrition and risk of malnutrition was 8.0% respective 29.1% of the study sample. Malnutrition was significantly more frequent in elderly subjects aged more than 85 years, in females, widowed and illiterate people. Moreover, participants who reported lower financial status were more often malnourished or at risk of malnutrition. Regarding health status, poor nutritional status was more common among those reporting more than three chronic diseases, taking more than three drugs daily, suffering from chronic pain and those who had worse oral health status. Also, depressive disorders and cognitive dysfunction were significantly related to malnutrition. After multivariate analysis following variables remained independently associated to malnutrition: living in the governorate of Nabatieh (ORa 2.30, 95% CI 1.35 -3.93), reporting higher income (ORa 0.77, 95% CI 0.61-0.97), higher number of comorbidities (ORa 1.22, 95% CI 1.12-1.32), chronic pain (ORa 1.72, 95% CI 1.24-2.39), and depressive disorders (ORa 1.66, 95% CI 1.47-1.88). On the other hand, better cognitive functioning was strongly associated with decreased nutritional risk (ORa 0.27, 95%CI 0.17-0.43). *Conclusion:* Our results highlighted the close relationship between health status and malnutrition. The identification of potential predictive factors may allow better prevention and management of malnutrition in elderly people.

Key words: Malnutrition, elderly, MNA.

Introduction

Nutritional disorders are serious and common findings in the elderly population. Indeed, malnutrition has been considered as "one of the greatest threats to health, well-being and autonomy of elderly people" (1). Malnutrition is linked to decreased muscle mass, higher infection rates (2), poor health outcomes (3) and impaired quality of life (4). In a study conducted among elderly patients visiting the emergency department, malnutrition was shown to be the strongest independent risk factor of short-term mortality (5).

Malnutrition is more prevalent in hospital and geriatric institutions, but since most elderly are living in their homes, it affects a high number of elderly subjects living in the community. Following a literature review published by Guigoz, presenting results of 25 studies including more than 3000 frail elderly subjects from mostly developed countries, nearly 9% are malnourished and 45% are at risk for malnutrition (6).

Poor nutritional status is more frequent in developing, low income countries. In these countries the impact of socioeconomic and health related factors may be more pronounced because of high inequities and limited access to health and social services (7). Hence, low socioeconomic status may limit food availability and food choice (8). In a study carried out among elderly people in Bangladesh, Ferdous et al (2009) showed that a higher income was associated with a lower risk of malnutrition after controlling for possible confounders (9). Moreover, among hospitalized elderly subjects , a higher prevalence of malnutrition was observed among less educated elderly ; in this study age and living alone were additional independent risk factors for poor nutritional status (10). Marital status may also play a role; in fact, couples have more regular meals than single or widowed subjects (11). Regarding place of residence, rural populations seem to be more exposed to malnutrition. In a study conducted in Malaysia among rural older adults, the authors observed that 38% were malnourished. In this study, insufficient money to buy food was a predictor of low BMI (12). Among age-related diseases, psycho-cognitive disorders may also have an impact on food intake. In a study among Mexican elderly, depression and cognitive impairment was related to increased risk of malnutrition (13). Other chronic and acute diseases are often accompanied by anorexia due to appetite reducing effect of

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cytokines and increased energy expenditure (14). Thus, understanding potential underlying causes of malnutrition will be of high importance in order to correct those reversible and accessible for prevention.

To our knowledge, nutrition in elderly Lebanese population remains unexplored. As a key factor for healthy aging, information about nutritional status will be of important public health concern especially because of growing elderly population. In addition, the relative impact of the factors contributing to nutritional status may be different from one population to another depending on the cultural background.

The purpose of the AMEL (Aging and Malnutrition in Elderly Lebanese) study was to evaluate nutritional status of community dwelling rural elderly people in Lebanon and to analyze potential predictors and independently associated factors. Our first published paper reported characteristics of the study sample and the prevalence of malnutrition and risk of malnutrition (15).

The present article aimed to study the relation between socio- economic indicators as well as physical and mental health characteristics and nutritional status among this representative sample of rural elderly Lebanese.

Methods

Study population

Participants in this study were 1200 community dwelling rural residents aged 65 years and over, living in the 24 Caza (districts) of Lebanon, which are forming five Mohafazat (governorates). Subjects were randomly selected and questioned at their homes by trained interviewers. Individuals on artificial nutrition were excluded from the study. Details of the sampling procedure have been published elsewhere (15).

Measurements and tools

As described in our previous paper (15), a multi component questionnaire including validated scales was used to assess the outcome variable (nutritional status) and several potential explanatory variables.

Nutritional status

The Mini Nutritional Assessment in its Arabic version was used assessed the nutritional status of the participants. The MNA, developed by Guigoz et al (16) is the most established, best validated and widespread nutritional assessment tool used among elderly persons (17). The MNA includes 18 questions regarding anthropometric, general, dietetic, and subjective assessment. The total score is situated between 0 and 30 points. A score less than 17 indicates malnutrition; between 17 and 23.5 we can consider the subject as at risk for malnutrition, whereas a score ≥ 24 indicates adequate nutritional status (16). In this study we defined "poor nutritional status" as being either malnourished or at risk of malnutrition.

Socio demographic indicators

These include gender, age, area of residence, marital status, educational level, financial status, the longest occupation held and question about health insurance. Income was categorized into > 600.000 LL (~400 USD) 300.000 – 600.000 LL and < 300.000 LL (~200 USD), according to the extreme poverty line (18) .

Physical and mental health status

Health status was assessed by number of chronic diseases and drugs taken daily as prescribed by a physician. We also asked for digestive disorders and chronic pain, as we consider these as potential risk factors for poor nutritional status. Oral health was analyzed through questions about chewing problems, total or partial loss of dentition, and wearing dental prosthesis. Cognitive status was assessed by the Mini-mental-state (MMS) examination(19). Due to the high level of illiteracy, we constructed a modified version adapted to illiterate subjects (MMS 2), whereas the original MMS (MMS 1) translated in Arabic language was used for literate elderly. As no cut-off points were defined in Lebanese elderly, the results were divided into quartiles. Thus individuals were classified into low cognition (1st quartile), intermediate cognition (2nd&3rd quartile), and high cognition (4th quartile). To assess mood, we used two instruments: the 5 item Geriatric Depression Scale (GDS-5), a five item scale allowing to detect depressive disorder in elderly persons at a score of two or above out of five (20) and the 5-item WHO Well Being Index (21) previously validated in the Arabic version and therefore more culturally adapted. This scale allows detecting depression among Lebanese elderly at a cut-off point less than 13 out of 25 (21). Scores were dichotomized according to these cutoffs in the present paper.

Statistical analysis

The Statistical Package for Social Sciences (SPSS) version 19.0 was used to enter and analyze data. We used chi-square tests to assess bivariate associations between class explanatory variables (socio-demographic indicators, physical and mental health characteristics) and nutritional status, whereas ANOVA was used to compare means across classes of nutritional status for continuous variables (age, MMS 1/2). Multivariate logistic regression analysis was performed to identify independent variables associated with malnutrition; odds-ratios with 95% confidence intervals were calculated. The dependent variable was nutritional status dichotomized as poor (malnourished or at risk as defined above) vs. normal. We introduced in these models the main explanatory variables that were associated with nutritional status at $p \leq 0.05$ in the bivariate analysis. In model 1, all socio-demographic predictors of nutritional status were introduced simultaneously. Then, model 2 included health related characteristics (comorbidities, chronic pain, edentulism and buccodental complaints) adjusted for those socio-demographic variables which were significantly associated to

poor nutritional status in model 1. In model 3, were entered mental health indicators (5 item-GDS score, MMS) which were adjusted for those variables significantly associated in model 1. A final model (model 4) was run with all the previously significantly associated variables in all three previous models as explanatory variables. In all models, age was forced.

Results

Nutritional status of the participants

The study sample included 1200 elderly subjects (609 women and 591 men) with a mean age of 75.7 years (SD=7.1). The prevalence of malnutrition and risk of malnutrition estimated by the MNA was 8.0% and 29.1 % respectively. Nutritional status of women was significantly worse than that of their male counterparts.

Nutritional status and associated factors

Table 1 shows the results of the bivariate analyses for socio-demographic factors. Female gender, higher age, illiteracy and poor income were significantly associated with poor nutritional status (p<0.001). Regarding place of residence, we found a higher level of nutritional disorders in South Lebanon and Nabatieh. In the latter, more than half of the participants were either malnourished or at risk of malnutrition.

Health related characteristics are shown in table 2. Individuals with high comorbidity and drug intake were significantly more often malnourished (p<0.001). Regarding oral health status, complaints about chewing problems, edentulism and wear of dental prosthesis were significantly

Table 1
Association between socio-demographic factors and nutritional status (MNA categories). Bivariate analyses

Variables	N[1]	malnourished %	at risk of malnutrition %	wellnourished %	p
Age mean (SD)	1170	77.72 (7.20)	76.43 (7.62)	74.46 (6.63)	<0.001
Age Class	1170				
65-75 y	646	5.7	25.2	69.1	<0.001
76-85y	408	10.0	33.1	56.9	
>85y	116	12.9	37.9	49.2	
Gender	1177				
M	582	6.9	22.9	70.2	<0.001
F	595	9.1	35.3	55.6	
Mohafazat	1177				<0.001
Mountlebanon	295	3.7	32.2	64.1	
North Lebanon	296	4.1	24.3	71.6	
Bekaa	244	4.9	27.9	67.2	
South Lebanon	145	13.8	25.5	60.7	
Nabatieh	197	19.8	36.0	44.2	
Marital status	1177				
Married	759	6.2	24.0	69.8	<0.001
Divorced/single	75	6.7	29.3	64.0	
Widowed	343	12.2	40.5	47.2	
Education	1176				
Illiterate	516	12.8	35.5	51.7	<0.001
Primary school	412	5.6	29.4	65.0	
Middle school	156	2.6	19.2	78.2	
High school/university	92	1.1	9.8	89.1	
Monthly income	1122				
< 300.000 LL [2]	519	8.5	36.6	54.9	<0.001
300.000 – 600.000 LL	302	5.6	28.5	65.9	
>600.000LL	301	8.0	15.6	76.4	
Financially dependent from children	1169				
No	400	6.8	20.5	72.8	<0.001
Partially	245	6.1	29.8	64.1	
Totally	524	9.4	35.7	55.0	
Main occupation	1174				
Farmer /self-employed	411	6.1	26.0	67.9	<0.001
Employee/manager	299	5.0	20.7	74.2	
Unemployed (including household)	464	11.2	37.5	51.3	

1. Number of respondents to this question, [2] LL = Lebanese pounds (300.000 LL = ~ 200 USD)

Table 2
Association between health related characteristics and nutritional status (MNA categories).Bivariate analyses

Variables	N[1]	malnourished %	at risk of MN %	wellnourished %	p
Number of chronic diseases	1176				
≤ 3 diseases	538	3.5	18.6	77.9	<0.001
>3 diseases	638	11.8	38.1	50.2	
Daily drug intake	1176				
≤ 3 drugs	444	2.5	19.8	77.7	<0.001
>3 drugs	732	11.3	34.8	53.8	
Chronic pain	1170				
Yes	522	13.0	37.4	49.6	<0.001
No	648	3.7	22.5	73.8	
Digestive disorders	1173				
Yes	339	13.6	34.2	52.2	<0.001
No	834	5.5	27.1	67.4	
Oral health status					
Chewing problems	1175				
Yes	330	11.5	30.6	57.9	0.008
No	845	6.5	28.5	65.0	
Edentulous (partially or totally)	1073				
Yes	711	11.7	31.6	56.7	<0.001
No	362	3.0	23.5	73.5	
Dentures (partial or complete)	1172				
Yes	554	11.2	33.9	54.9	<0.001
No	618	5.2	24.8	70.1	
5 item GDS score[4]	1168				
≥ 2	470	16.2	44.3	39.5	<0.001
< 2	698	1.9	19.1	79.0	
WHO-5-A score[5]	1169				
< 13	536	16.2	42.9	40.9	<0.001
>= 13	633	0.6	17.7	81.7	
MMS 1[6] mean (SD)/quartiles	605	17.9 (7.5)	24.2 (4.7)	26.7 (3.6)	<0.001
<24	139	10.8	38.1	51.1	<0.001
24-26	137	2.2	20.4	77.4	
27-28	102	2.0	26.5	71.5	
>=29	227	0.4	11.5	88.1	
MMS 2[7] mean (SD) /quartiles	500	11.4 (6.2)	17.7 (6.1)	22.2 (5.1)	<0.001
<14	108	37.0	46.3	16.7	<0.001
14-19	118	11.9	53.4	34.7	
20-23	116	3.4	32.8	63.8	
>=24	158	1.3	24.1	74.6	

1. Number of respondents to this question; 2. ADL: Activities of Daily Living; 3. IADL: Instrumental activities of daily living: missing values due to participants without telephone or with no drug intake; 4. GDS score >=2: depression; 5. WHO score <13: depressive disorders; 6. MMS 1: original version; 7. MMS 2: adapted for illiteracy;

associated with poor nutritional status (p<0.001). In addition, a significant association was observed between cognitive function and nutritional status (p<0.001): whatever the instrument, the proportion of malnourished or at risk individuals significantly decreased with increasing cognitive performance.

Table 3 displays results of multivariate logistic regression analyses with poor nutritional status as outcome variable. model 1 shows a strong independent association between poor nutritional status and several socio-demographic indicators: age, living in the Mohafazat of Nabatieh (compared to Mount Lebanon), widowhood, low income, low educational status and being unemployed. In model 2 (health related characteristics adjusted for the previous variables), age, living in the Mohafazat of Nabatieh, and low income remained significantly associated to poor nutritional status. Furthermore, a strong association (p<0.001) was found between impaired nutritional status and the number of comorbidities (OR: 1.21; IC95%:

Table 3

Binary logistic regression models for malnourished/at risk of malnutrition versus well nourished regarding socio demographic indicators and health status variables

Measures	Model 1[1] OR (95% IC)	p	MODEL 2[2] OR (95% IC)	p	Model 3[3] OR (95% IC)	p	Model 4[4] OR (95% IC)	p
Socio demographic indicators								
Age	1.032 (1.011-1.053)	0.003	1.032 (1.009-1.055)	0.006	1.013 (0.990-1.036)	0.268	1.014 (0.991-1.014)	0.242
Gender	0.851 (0.563-1.288)	0.446						
Mouhafaza		<0.001		<0.001		<0.001		0.003
North vs Mount Lebanon	0.671 (0.454-0.991)	0.045	0.737 (0.455-1.194)	0.216	0.772 (0.501-1.190)	0.241	0.858 (0.550-1.337)	0.499
South vs Mount Lebanon	1.523 (0.953-2.432)	0.078	1.309 (0.786-2.180)	0.301	0.984 (0.557-1.741)	0.957	0.864 (0.471-1.584)	0.636
Nabatieh vs Mount Lebanon	2.896 (1.847-4.542)	<0.001	2.904 (1.776-4.748)	<0.001	2.255 (1.348-3.773)	0.002	2.306 (1.353-3.931)	0.002
Bekaa vs Mount Lebanon	0.768 (0.515-1.146)	0.196	0.670 (0.429-1.046)	0.078	0.874 (0.566-1.352)	0.546	0.891 (0.570-1.392)	0.613
Marital Status		0.037		0.517		0.019		0.074
Divorced/single vs married	1.145 (0.637-2.058)	0.651	1.167 (0.630-2.160)	0.624	0.465 (0.234-0.925)	0.029	0.525 (0.262-1.054)	0.070
Widowed vs married	1.535 (1.107-2.129)	0.010	1.219 (0.858-1.732)	0.269	1.265 (0.892-1.794)	0.187	1.206 (0.841-1.729)	0.309
Education		0.003		0.063		0.022		0.174
Primary school vs illiterate	0.795 (0.583-1.083)	0.145	0.791 (0.560-1.117)	0.183	0.766 (0.543-1.079)	0.127	0.774 (0.543-1.102)	0.155
Middle school vs illiterate	0.534 (0.333-0.856)	0.009	0.656 (0.388-1.111)	0.117	0.517 (0.303-0.880)	0.015	0.671 (0.388-1.160)	0.153
High school/university vs illiterate	0.282 (0.129-0.620)	0.002	0.339 (0.143-0.805)	0.014	0.332 (0.132-0.837)	0.019	0.423 (0.167-1.074)	0.070
Income (high vs low)	0.715 (0.583-0.876)	0.001	0.720 (0.582-0.891)	0.003	0.772 (0.616-0.967)	0.024	0.774 (0.615-0.975)	0.030
Financial dependency		0.791						
Totally vs independent	1.148 (0.773-1.703)	0.494						
Partially vs independent	1.065 (0.738-1.539)	0.736						
Occupation		0.002		0.207		0.435		0.723
Employee vs farmer	1.235 (0.789-1.933)	0.355	0.987 (0.604-1.612)	0.959	1.206 (0.730-1.990)	0.465	1.076 (0.639-1.811)	0.782
Self employed vs farmer	1.083 (0.666-1.763)	0.748	0.850 (0.498-1.452)	0.553	0.979 (0.566-1.683)	0.931	0.815 (0.463-1.437)	0.480
Unemployed vs farmer	2.271 (1.433-3.597)	<0.001	1.331 (0.872-2.030)	0.185	1.339 (0.864-2.074)	0.192	1.055 (0.668-1.667)	0.817
Physical Health Status								
Number of comorbidities			1.210 (1.097-1.333)	<0.001			1.218 (1.122-1.323)	<0.001
Number of drugs			1.037 (0.970-1.109)	0.282				
Chronic pain			2.019 (1.479-2.757)	<0.001			1.719 (1.238-2.389)	0.001
Digestive disorders			1.134 (0.953-1.350)	0.157				
Edentulism			1.348 (0.947-1.917)	0.097				
Buccodental complaints			0.750 (0.534-1.053)	0.097				
Mental Health Status								
MMS (quartiles)[5]						<0.001		<0.001
2nd quartile vs 1st quartile					0.593 (0.390 -0.902)	0.014	0.582 (0.378-0.896)	0.014
3rd quartile vs 1st quartile					0.493 (0.316-0.769)	0.002	0.487 (0.308-0.770)	0.002
4th quartile vs 1st quartile					0.301 (0.193-0.471)	<0.001	0.274 (0.172-0.435)	<0.001
5 item GDS score[6]					1.760 (1.560-1.986)	<0.001	1.663 (1.467-1.885)	<0.001

1. Model 1 = Logistic regression analysis between poor nutritional status (malnutrition/at risk of malnutrition) and socio-demographic indicators; 2. Model 2 = association between poor nutritional status and health related factors adjusted for socio-demographic indicators; 3. Model 3= association between poor nutritional status and mental health adjusted for socio-demographic indicators; 4. Model 4: adjusted for all significantly associated variables; 5. each quartile includes individuals from respective quartiles of MMS 1 (original form) and MMS 2 (adapted for illiterate); 6. continuous variable: higher score = more depressive disorders.

1.09-1.33). In addition, subjects complaining of chronic pain were two fold more likely to present a poor nutritional status. When introducing mental health (model 3), beside the persistent association with area of residence, income, and marital status, a strong relationship was found between impaired cognitive function or mood and poor nutritional status ($p<0.001$).

The final model (model 4) presents the adjusted relationship between poor nutritional status and the previously significantly associated covariates. The Nagelkerke R2 was 0.396, which means that nearly 40% of the variance of poor nutritional status was related to the combination of the introduced explanatory variables. It appeared that living in the Mohafazat of Nabatieh remained strongly associated with poor nutritional status, the odds ratio being more than doubled as compared to Mount Lebanon. Moreover, higher income was associated with a 33% lower risk of poor nutritional status. Among the health –related variables, a higher number of comorbidities and reporting chronic pain remained both significantly related to poor nutritional status. Furthermore, elderly people with depressive disorders (higher GDS 5 score) were 1.7 fold more likely to be either at risk for malnutrition or malnourished. Finally, a strong and persistent relationship was observed between nutritional status and all MMS categories; in fact odds ratio decreased gradually with increasing level of cognitive function (from 1st to 4th quartile).

Discussion

To our knowledge, this appears to be the first community-based study investigating the nutritional status of rural elderly Lebanese in relation to the main potentially associated factors. As already showed in the previous published paper (15), poor nutritional status, defined as either malnutrition or risk of malnutrition, was present among 37.1% of the sample, with a higher proportion found in the female population. The higher

prevalence of malnutrition among females was already mentioned in the literature, especially in developing countries (9, 22). Thus, women in low income countries may be disadvantaged in multiple domains due to discriminatory practices, multiple pregnancies and lack of attention to health (23). However, gender was no longer associated with nutritional status when other socio-demographic characteristics were taken into account, suggesting that lower education, income, occupation and more frequent widowhood of women explained their poorer nutritional status (15). Indeed, in the final regression model, among socio-demographic variables, only area of residence (Mohafazat) and income remained significantly associated to nutritional status. Living in the Mohafazat of Nabatieh was related to a more than two fold increased risk of being either malnourished or at risk of malnutrition, regardless of socioeconomic factors and health. This was a surprising finding, which may be explained by residual confounders; further research is needed in order to find possible explanations. Given this fact, analyzing food consumption of our study sample will be of great importance and regional differences may be found in dietary habits. Limited food supply and access to health care may also explain the disadvantaged status of older Nabatieh residents, suggesting public health interventions.

Among socioeconomic status, higher income was inversely associated with malnutrition. This fact was already reported in the literature: in a study conducted among elderly subjects in rural Bangladesh, having no income was significantly associated with a lower MNA score (9) . Other authors mentioned that elderly individuals who live in poverty are at greater risk of malnutrition (24). This may be due to reduced food availability, consumption of food low in essential nutrients (9) and growing food insecurity (25).

Another important indicator of socio-economic status was education whose association with nutritional status persisted in multivariate analysis when adjusted for other socio-demographic variables, such as income. In fact, education and income are conceptually different and thus not interchangeable; each of them refers to different underlying pathways (26) and contributes separately to nutritional intake (27). Several authors found that a higher educational level contributes to a better nutritional status (9, 28, 29). Educated people, for example, are more informed about the importance of food for health (9) and more able to understand nutritional guidelines (30).

When introducing health related variables in the regression model, the association between education and nutritional status became less significant. However, odds ratios were virtually unchanged but the confidence interval was wider because of the many explanatory variables in the model, suggesting an independent impact of income and education on nutritional status.

By contrast, low income remained strongly associated with malnutrition whatever the model, suggesting that economic factors are a powerful driver of nutritional status in this population.

Regarding health status, morbidity and nutritional status are linked in various ways: in our study, the number of chronic diseases was associated with an increased risk of poor nutritional status. Ferdous et al (9) reported a positive association between the burden of disease and malnutrition in a rural population of elderly people living in Bangladesh. In a prospective study carried out by Beck et al (34) among Danish elderly, the authors found a positive relationship between the risk of malnutrition (based on MNA) and frequency of hospitalization. The relation between these two conditions is complex. In fact, one of the major consequences of malnutrition is an increased risk of morbidity, especially the risk of nosocomial infection (35) and the risk of falls and fractures (36). On the other hand numerous diseases are accompanied by decreased food intake and metabolic changes which have a negative impact on energy balance (14, 37). This may create a vicious circle between malnutrition and disease.

An original finding of our study was the association between chronic pain and impaired nutritional status. The relationship remained in the final model after introducing all potential confounders. In fact, persistent chronic pain may reduce appetite and pleasure related to food intake (38). Although chronic pain is highly prevalent among geriatric population (39), studies analyzing the impact of chronic pain on food intake and nutritional status are lacking.

Furthermore, depression is one of the best recognized risk factors of malnutrition in geriatric population (40). About 90 % of elderly subjects suffering from depression experience weight loss against only 60% in younger adults (41). This may be due to lack of appetite, decreased interest in self-care and physical weakness (42). In our study, we found a strong association between poor nutritional status and depression. However, due to the cross-sectional design, the direction of the relationship cannot be inferred from our study. Indeed, current epidemiological data suggest that deficiencies in micronutrients which are essential in brain metabolism such as B vitamins, vitamins C and E, and omega-3 fatty acids may increase the risk of depression (43).

Regarding cognition, a negative association was found between poor nutritional status and better cognitive function. Similar findings were reported by several authors (13, 44, 45). Decreased food intake and eating behavior disturbances are typically observed in patients suffering from Alzheimer's disease (46); these patients may forget to eat, forget how to prepare meals or refuse to eat (47). Even mild cognitive decline may be accompanied by nutritional changes. In a study conducted by Shatenstein et al (48), the authors reported poor nutritional intakes and higher nutritional risk among patients with early stage Alzheimer disease when compared to cognitively intact elderly subjects. However, here again reverse causation cannot be excluded. Indeed, consumption of several foods or nutrients including antioxidant compounds such as vitamins C and E, and long-chain omega-3 fatty acids may

influence the development of dementia (49). For instance, in the Three-city cohort study , regular consumption of fruits , vegetables and fish was associated with a decreased risk of dementia among French elderly individuals (50). Thus, a vicious circle may underlie the link between poor dietary habits, nutritional status, and impaired cognition.

The major strengths of our study include the evaluation of a large rural sample with a comprehensive assessment of numerous variables potentially linked to nutritional status. Moreover, our sample was representative of rural elderly people and participation rate was above 90%. However, several limitations have to be mentioned such as the cross-sectional design which does not allow establishing causality. Furthermore, differences in cognitive status among individuals may be responsible for information bias related to memory loss. Also, several measures relied on self report such as type and number of chronic diseases. Finally, there may be some unrecognized factors and remaining residual bias.

We can conclude from this study that elderly people suffering from poor financial condition, those with multiple chronic diseases, those reporting chronic pain or presenting mental disorders were at high risk of malnutrition. Poor nutritional status was significantly associated to the Mohafazat of Nabatieh; further investigations are needed to clarify these findings. In addition, efforts should be made to improve the attention of health professionals and care givers to malnutrition, especially in the context of the demographic changes. Specific training courses should be organized to enhance knowledge about nutrition and community based routine screening of more vulnerable groups, such as poor people living in underprivileged regions, and those suffering from multiple comorbidities, should be implemented. In the same way, nutritional guidelines for elderly people have to be developed.

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Authors' contribution: CB initiated, organized and supervised the survey, contributed to data interpretation and writing the manuscript. PS provided expertise in sampling methods, planning and organizing the survey and data analysis. PBG supervised the conception and design of the survey and the interpretation of the data. PS and PBG revised the manuscript critically and gave final approval of the version published.

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