Assessment of Quality of Life in Multiple Sclerosis Patients: The Impact of Dietary Habits, Socio - Demographic and Clinical Characteristics

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Abstract: *<u>Introduction</u>: Multiple Sclerosis (MS) is a chronic inflammatory neurological disease with an increased incidence. <u>Aim:</u> Our aim was to evaluate the quality of life of MS patients the effects of implemented nutritional practices, as well as their socio - demographic and clinical characteristics, which have been understudied in Greece. <u>Materials and Methods</u>: A cross - sectional study, utilizing convenience sampling was conducted. The study sample included 137 MS patients. The data collection instruments included the MSQOL - 54 Multiple Sclerosis Quality of Life Questionnaire and the dietary intake frequency scales Mediterranean Diet Score (MedDiet score) and Mini Nutritional Assessment (MNA). <u>Results</u>: The majority of patients were female (75.2%). Women (p=0.002), younger patients (p=0.002), those who worked (p=0.003) and patients with normal nutritional status (p<0.001) reported better physical health. In addition, normal nutritional status, younger age and no cortisone administration were related to greater emotional well - being, increased energy, and better social functioning.74.5% of participants had normal MNA, whereas the MedDiet scores appeared to be relatively good ($\bar{x}$ =29.9, SD = 6.1, range 0 - 55). The MedDiet score was neither significantly associated with the MSQOL - 54 scales, nor with patients' sociodemographic characteristics. In contrast, the MNA score was found to be significantly and positively associated with physical (p=0.002) and mental health (p=0.001). <u>Conclusions</u>: The findings suggest that healthy eating habits have a positive impact on Quality of Life (QoL), improving thus physical and mental health. Younger, employed and women report greater QoL. Similar studies need to be carried out with larger samples.*

Keywords: multiple sclerosis (MS), quality of life (QoL), nutrition, clinical characteristics, social characteristics, demographics

Highlights:

- The Mini Nutritional Assessment (MNA) score was statistically significantly associated with the Multiple Sclerosis Quality of Live - 54 (MSQOL - 54) score. In contrast, the Mediterranean Diet Score (MedDiet score) had no statistically significant associations with any sociodemographic factor or scale.
- Patients with malnutrition or at risk of malnutrition reported significantly worse physical and mental health.
- Greater physical health and QoL were reported by women, younger and employed patients, as well as by those with a normal nutritional status.
- Lower levels of pain were associated with younger age, physical activity and normal nutritional status.
- Overweight patients were found to have worse cognitive function compared to those with normal BMI. On the other hand, university graduates or MSc/PhD holders reported improved cognitive function compared to patients with lower educational attainment.

Abbreviations:

- MS = Multiple Sclerosis
- MSQOL - 54 = Multiple Sclerosis Quality of Life Questionnaire
- MedDiet score = The Mediterranean Diet Score
- MNA = Mini Nutritional Assessment
- BMI = Body Mass Index
- QoL= Quality of life

1. Introduction

Multiple Sclerosis (MS) is a chronic inflammatory disease of the central nervous system (CNS), affecting thousands of people worldwide. The pathogenesis of MS has not been fully elucidated, yet a mechanism that has been investigated in recent years is the dysregulation of the immune system [1]. The clinical manifestations of the disease are varied, but in a more positive note, several drugs have been readily available as of late aiming to control recurrences of the disease or even delay the progression of disability. Nevertheless, there is no cure, whilst the course of the

disease remains obscure [2]. Environmental risk factors for the onset of the disease are considered to include low vitamin D levels, limited sun exposure, smoking, exposure to the Epstein - Barr virus, obesity and poor diet. However, there is considerable variation in the clinical manifestation and course of the disease, something that justifies the characterization of MS as a disease with a thousand faces [3, 4].

In recent years, relevant research has focused on the role of diet and whether its combination with drugs could have a positive effect on the course of the disease and recurrence risk in MS [5.6.7]. Several patients are trying to adhere to a healthier diet, in the hope that this might help to improve their condition [8]. MS sufferers, motivated by their treating physicians, can embrace healthy eating habits with potential positive effects on disease outcomes [9]. More specifically, it has been argued that a balanced diet positively affects physical and mental health, improves functionality impairment and leads to an improved QoL [10.11]. Several researchers put forward the theory suggesting that MS is a lifestyle disease. Adopting healthy choices seems to motivate patients towards improved disease management and is related to reduced fatigue and pain, improved psychological and cognitive status, as well as better QoL [12.13].

Most people almost always associate QoL with health, without this being the only connotation. In 1995, the World Health Organization (WHO) described QoL as the perception and attitude an individual has about life in relation to his/ her values, ideals, goals, aspirations, and beliefs within the environment in which he/ she lives [14]. That is, it is essentially a combination of factors, both subjective and objective. Each individual, depending on his/ her experiences and culture, has formed his/ her own perceptions of QoL. In case of individuals suffering from chronic neurological conditions, it is possible that they adjust their perceptions of QoL according to the stage of their disability. An acute relapse usually contributes to the deterioration of a patient's QoL. Conversely, therapeutic approaches aiming to decelerate disability and reduce relapses may contribute to QoL improvement [15]. Following the diagnosis of the disease, it is of paramount importance to maintain a high level of QoL in the long term, as it may contribute to positive disease outcomes and the reduction of potential relapses [16].

Research interest in multiple sclerosis is unabated, taking into consideration that the disease is one of the most common neurological conditions, whilst precipitating a variety of effects. MS does not discriminate against gender, age, body type, ethnicity, marital status, educational level, economic level and lifestyle. Unquestionably, the most important thing for sufferers and their families is improved health, well - being and a better QoL. The question arising here is how to achieve this goal and whether interventions targeting modifiable factors, such as diet, could contribute to a better QoL [17, 18, 19].

In Greece, research aboutQoL and nutrition is limited. The present study aimed to investigate potential associations between the QoL of people with MS and: a) their dietary habits, b) their socio - demographics and c) their clinical characteristics, utilizing the MSQOL - 54 scale [20]. To assess their eating habits, two dietary intake frequency scales were utilized: the Mediterranean Diet Score [21] and the Mini Nutritional Assessment MNA [22].

It is possible that a healthy lifestyle and diet can help considerably MS patients in the course of their disease, as well as improve their QoL. Additionally, the investigation of several socio - demographic - medical characteristics, including age, gender, employment, education, and nutritional status, can broaden our knowledge about factors influencing QoL during the progression of the disease. Therefore the identification of potential factors related to patients' QoL, as well as the elucidation of the role of adequate nutrition, allows us to obtain a more accurate understanding of the disease.

2. Materials and Methods

A. Study Design
A cross - sectional study was carried out with a convenience sample in the context of a public hospital in Attica, Greece. One hundred and thirty - seven 137 adults, diagnosed with MS, presenting to the hospital for treatment or follow - up were included in the study. The response rate was 100%. Data were collected from June 2021 to May 2022. Inclusion criteria were a) patients presenting at the outpatient clinics, with odd registration numbers, b) participants had to be adults ≥ 18 years of age, c) have a good understanding of the Greek language and d) provide signed informed consent to participate in the study. Exclusion criteria were a) MS diagnosis, cortisone administration, modification of treatment, participation in a clinical trial, within the last 6 months and b) patients with psychiatric disorder, or comorbidity.

The data was collected using questionnaires which were obtained by personal interview by the same researcher, lasting approximately 25 (twenty - five) minutes, in a quiet room, both in the outpatient and inpatient Neurology Clinic. The sample selection was randomized. After being informed and consenting to the study, participants provided information on a baseline questionnaire regarding their sociodemographic characteristics and medical history, as well as on the MSQOL - 54, MedDiet score, and MNA.

This study was carried out in accordance with the principles of the Declaration of Helsinki. Approval was given a) by the Ethics and Deontology Committee (E. H. D. E) of the University of Western Attica (P. D. A.) (19th/ 07 - 06 - 2021/ 43262/02 - 06 - 2021) and b) by the Scientific Committee of the General Hospital of Nicaea Piraeus (issue ID.16th, decision of the 21st /02 - 09 - 2020/44044). These measures ensure that the study was conducted in accordance with ethical standards as defined in the 1964 Declaration of Helsinki and its subsequent amendments or comparable ethical standards. All participants provided written informed consent.

B. Questionnaires
The Multiple Sclerosis Quality of Life - 54 (MSQOL - 54) scale was developed by Vickrey et al, in 1995 and has been

extensively used for the patients' QoL assessment [23, 24]. It comprises of questions included in the Short Form 36 - Item health survey (SF - 36), as well as 18 additional items specifically addressed to patients with MS [25]. The SF - 36 questionnaire is widely used and includes two composite scores regarding physical and mental health. In the MSQOL - 54 questionnaire, these two items were supplemented with 8 additional scales in the areas of health anxiety, sexual function and satisfaction with sexual function, the general quality of life, cognitive function, energy, pain and sociability. The score of each scale is extracted from the average of the questions, and a higher score indicates a better QoL.

The MedDiet questionnaire is a popular questionnaire measuring adherence to the Mediterranean diet [26, 27]. The questions cover 156 foods and beverages that belong to the following 11 food groups: refined grains, fruits, vegetables, legumes, potatoes, fish, meat, poultry, full - fat dairy products, olive oil and alcohol. The total score ranges from 0 to 55, indicating that the higher the score, the greater the adherence to the Mediterranean diet.

The Mini Nutritional Assessment is a validated nutrition assessment tool consisting of 18 items [28, 29]. The first 6 questions provide an assessment of nourishment level (the score ranges from 0 to 14 points). For the other 12 questions (the score reaches up to 16 points) the evaluation score is estimated. The addition of both scores presents the overall nutrition assessment indicating either a normal nutritional status or risk of malnutrition or malnourishment

C. Statistical analysis

Quantitative variables were expressed as mean (Standard Deviation) or as median (interquartile range). Qualitative variables were expressed as absolute and relative frequencies. Student's t - tests were used for the comparison of mean values between the two groups. Pearson's r and Spearman's rho correlation coefficients were used to explore the association of two continuous variables. Multiple linear regression analysis was used with dependent the MSQOL - 54 scales in a stepwise method (p for entry 0.05, p for removal 0.10). The regression equation included terms for all patients' demographics, information for their disease and for their nutritional habits. Adjusted regression coefficients (β) with standard errors (SE) were computed from the results of the linear regression analyses. All reported p values are two - tailed. Statistical significance was set at p<0.05 and analyses were conducted using SPSS statistical software (version 22.0).

3. Results

The study sample included 137 MS patients (75.2% of whom were women). Their characteristics are presented in **Table 1** (part II, page1). The majority of patients were 41 - 50 years old (31.4%) and 30.7% were 31 - 40 years old. Mean BMI was 25.9 kgr/m² (SD=5.1 kgr/m²) and 34.1% of participants were overweight. Furthermore, 54.0% of the patients were married and 54.7% had children. Mean years since diagnosis were estimated at 10.8 (SD=7.2 years). The vast majority of MS patients were under treatment and had taken cortisone (93.4% in both cases). Furthermore, 40.1%

of the patients attended a physical activity program and 44.5% were smoking. Most of the patients had normal nutritional status (74.5%) and the mean MedDiet score was 29.9 (SD=6.1).

MSQOL - 54 scores are described in **Table 2** (part II, page2). MedDiet score was not significantly associated with any of the MSQOL - 54 scales, while MNA scores were significantly and positively associated with most of the MSQOL - 54 scores, indicating that normal dietary habits are associated with improved QoL.

When MSQOL - 54 scores were compared between the groups of Malnourished/At risk of malnutrition patients and patients with Normal nutritional status **Table 3** (part II, page 3), it was found that Malnourished/ At risk of malnutrition patients had significantly poorer physical health and emotional wellbeing, experienced greater pain, decreased energy levels, worsened social function, greater health distress and worse perception of overall QoL. In total, patients who were Malnourished/ At risk of malnutrition were found to have worse mental and physical health.

Multiple regression analysis revealed that women, younger patients, employed and patients with normal nutritional status had better physical health **Table 4** (part II, page 3). Additionally, higher levels of education and lower age were significantly associated with fewer role limitations due to physical problems. Similarly, a higher level of education was significantly associated with fewer role limitations due to emotional problems. Younger age, normal nutritional status and attendance of a physical exercise program were associated with lower pain levels. Furthermore, younger age, normal nutritional status and no cortisone administration were associated with greater emotional well - being, increased energy and improved social function. Younger patients and those with normal nutritional status had better perceptions of their health. Overweight patients were found to have worse cognitive function compared to those with normal BMI. On the other hand, university graduates or MSc/PhD holders reported improved cognitive function compared to patients with lower educational attainment. Patients with normal nutritional status reported lesser health distress. Younger, non - smokers and employed participants reported better sexual function, whilst married patients experienced less positive change in their health. Furthermore, married, employed and younger patients were significantly more satisfied with their sexual function. Overall women, younger patients, and those who had never taken cortisone and had a normal nutritional status had greater QoL. What is more, younger age, normal nutritional status and no cortisone administration were associated with better physical and mental health in total. Last but not least, patients, who were working reported better physical health overall.

4. Discussion

The sample of the study consisted of MS patients receiving treatment in an Attica hospital. The majority of patients were women (75, 2%), a finding that is in line with the findings of other studies, suggesting that MS incidence is higher in women [30, 31, 32]. Women may appear to be more

susceptible to autoimmune diseases, but men may be at risk of faster and more severe disease progression. The underlying cause for these gender - based differences remains unknown [33]. In recent years, it has been hypothesized that several genes are involved in MS pathogenesis, steering research attention towards genetic testing, without any remarkable results, so far [34, 35]. In the present study, women scored their QoL higher than men (p = 0.002), which is consistent with previous studies, where women seemed to be better adapted to the disease than men, who scored their QoL lower [23, 36, 37]. Another study that investigated the prediction of good health self - assessment from New York City showed that biological sex was not associated with health [38].

Patients with higher education represented 56.2% of our sample. Similarly, in a recent prospective study of 122 subjects, 55.73% of patients had a university education [31]. Patients with higher academic attainment have been shown to have better memory and process information better [39]. Additionally, parents with high educational levels, especially the mother, seem to provide improved access to information and increased awareness about the disease. Patients along with their parents realize what is beneficial and works for them, acquiring thus the necessary skills to better cope with the disease [40]. Concerning the association between QoL and education, multiple regression analysis in our study showed that individuals with high education reported better cognitive function compared to individuals, whose education level was lower (p=0.001). Education is considered an indicator of cognitive reserve, as are occupation type and cognitive activities [39]. A higher level of education probably allows MS patients to pursue better jobs. Within a highly competitive job market, the unemployment effect may be more pronounced among chronic patients, such as MS patients, as they have to face barriers related to their age, as well as physical and mental problems [41]. In a large multicentre study of 2, 738 MS patients over age 60, from Europe and America, 3.1% were unemployed, 33.9% were employed or underemployed, and 37% were retired (furthermore 26% were disabled, homemaker and other) [42]. On the other hand, in other countries, percentages of MS patients, who are employed, are considerably higher, as in the case of Kenya, where the percentage of MS, who work is 78.41% [43]. In a systematic review, 26 studies were selected. The average age of the patients was 46.2 years and the unemployment rate was 59%. The specific assessment was carried out in the period 2002 - 2011 where the MS had an impact on their work situation [44]. In our study, 54% were employed, 21.2% unemployed and 19% retired. It was found that working patients reported better physical health and QoL. Indeed, it has been found that working patients seem to rate their QoL higher than non - working patients, with work being a criterion for overall patient performance, which in turn positively affects their QoL [45, 46].

As far as age is concerned, younger patients reported both better physical and mental health, as well as improved QoL (p=0.027). Nevertheless, older subjects reported worse physical health. This finding is expected, as age imposes limitations on most individuals. When besides other comorbidities due to older age, a chronic neurological disease such as MS co - exists, it is only reasonable that the difficulties faced by the individual are more severe [47, 48].

Previous studies have shown that smoking presents a high association with the risk of MS but a low association with disease progression [49]. It should be noted that passive smoking is considered a risk factor for the development of the disease [50]. In our study, slightly less than half of the patients reported smoking (44.5%). Multiple regression analysis showed that non - smokers (p = 0.029) were positively affected in the area of sexual health. Smoking was implicated as a risk factor for sexual dysfunction in MS patients in a study conducted in Iran, where its prevalence was fairly high [51]. Better sexual health was also reported by younger (p<0.001) and employed patients (p=0.037). Married patients did not appear to experience an improvement in their health compared to single people, whilst reported being satisfied regarding their sexual function. Accordingly, in another study married MS patients reported good sexual function and emotional well - being [48].

In terms of weight, half of the participants in our study were of normal body weight (50.4%). A study in which data were obtained from the North American Research Commission registry, showed that people, who did not follow a specialized diet regime, were more likely to be obese and more prone to developing progressive MS [52]. Another synchronous study with 5, 832 participants with MS showed that excessive visceral obesity was a cause of severe disability in 47% [53]. A healthy and good quality diet was associated with milder disease symptoms and progression [54]. In the present study, overweight patients reported inferior cognitive function (p=0.033) compared to patients with normal BMIs. The findings of a study suggested that a specific microbiome profile affects overweight individuals. The gut microbiome was found to affect memory functions, with treatment of the gut microbiome creating a positive outlook [55, 56].

It has been posited that, in the context of MS, dietary restriction may contribute positively to the disease due to its neuroprotective action. Reference is made to specific dietary interventions to prevent and treat the disease [57]. It is noteworthy that a specific diet cannot substitute recommended medication, but it seems that a dietary intervention can probably improve MS patients' health status, at least to some extent [9]. Nutritional plans designed to address malnutrition, as well as manage diet - related diseases are limited [58]. Our study showed that people, who were malnourished reported worse overall QoL (p=0.004). It is thought that malnutrition is associated with the advancement of the disease stages [59]. The findings of a study with a sample of 2, 087 MS patients showed that there is a statistically significant association between healthy eating habits, QoL and low likelihood of disability [10]. A cross - sectional study conducted in North America with 6, 989 participants linked diet to disability and symptom severity in MS patients. It appeared that patients with better diet quality presented lower levels of disability as well as depression, while a healthy lifestyle reduced fatigue, pain, depression and cognitive dysfunction [13]. Similarly, in Australia, in a study of 1, 490 people, healthy eating habits

were associated with very good health and QoL outcomes overall [19].

The findings of a study conducted in the Netherlands with 728 MS patients were consistent with the above - mentioned studies, where better QoL was associated with better diet quality. Adherence to a balanced diet was found to be rather beneficial, for women who followed it [23]. In contrast, an unhealthy dietary pattern was associated with a threefold increased risk of MS, whereas a healthy diet was associated with a 74% reduction in the risk of disease [60]. Evidence indicates that by making some modifications in their lives, MS patients showed improvement in their clinical disease progression and QoL [61, 62]. A healthy lifestyle was associated with better QoL. Lifestyle - related behaviours have a direct relationship with QoL in people with MS, while physical activity and healthy eating, promote well - being and improved QoL [63]. In general, MS patients appear less active than healthy individuals and report worse QoL due to the effects of the disease, whereas physical activity appears to be beneficial for their health [64, 65].

Even pain, a familiar symptom of the disease, which has a detrimental impact on MS patients' QoL, seems to be negatively associated with physical activity, with sufferers being more active and perceiving lower pain levels [66]. Perception of pain does not seem to differ significantly between genders. Nevertheless, in our study, younger (p < 0.001), physically active (p = 0.044) and patients in good nutritional status (p = 0.037) seemed to experience less pain [38, 67]. It is reasonable to expect that in women with relapsing - remitting multiple sclerosis (RRMS) pain is more severe when compared to healthy women [68]. Pain intensity does not seem to be dependent on MS type, but rather appears to be associated with the presence of severe disability [69]. Both exercise and a healthy diet seem to contribute to decreased pain [70]. As for the latter, a balanced diet provided nutrients and energy, while also affecting patients' well - being [71].

As far as our findings are concerned, which indicate that QoL was greater in patients not taking cortisone, nothing relevant was found in the extant literature (PubMed, Google Scholar, Medline) within the last decade. Patients who did not need cortisone administration are probably considered to be amongst the "lucky" ones, whose disease progression appears to be smooth.

5. Conclusions

Good nutritional status and social and mental activities appear to be key points in achieving a high level of quality of life for patients with MS. In this context, many factors are associated with improved physical or mental health and, by extension, with a better quality of life. Among them are female gender, employment, higher level of education, physical activity, no smoking and younger age of patients, who manifest greater sexual activity.

Declarations

A. Study Limitations
The present study faces several limitations including the small sample size, as well as the fact it was conducted in a single healthcare institution. The specific public hospital was selected due to the existence of an organized inpatient and outpatient Neurological Clinic, where a significant number of patients with MS are monitored. For practical reasons, this enabled the researchers to focus more adequately on the research goals. The coronavirus pandemic was a factor that deterred the collection of a larger sample, as several patients turned to paperless prescription and avoided hospital visits. Nevertheless, respondents were very positive aboutresponding and participating in the study. The small sample size does not allow for the generalization of the results and findings of the study to the entire population of patients with MS in Greece. Therefore, the findings of the study are merely indicative. In addition, the self - rating of people with MS, on the MSRS - R scale, was subjective and thus systematic error may have been introduced.

B. Content for participation – Content for publication
All the participants provide informed consent to collect and share data.

C. Authorship
All authors contributed to the study's conception and design. Material preparation, data collection and analysis were performed by Metaxouli Konstantina. The first draft of the manuscript was prepared by Metaxouli Konstantina and Margari Nikoletta. All authors read and commented on the manuscript and approved the final manuscript.

D. Conflict of interest
None.

Author Profile

Part II

Personal information: Fifty - five years old, married with two boys.
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Tables
Table 1: Sample Characteristics

		N (%)
Gender		
	Women	103 (75.2)
	Men	34 (24.8)
Age		
	18 - 30	14 (10.2)
	31 - 40	42 (30.7)
	41 - 50	43 (31.4)
	51 - 60	36 (26.3)
	61+	2 (1.5)
BMI, mean (SD)		25.9 (5.1)
BMI		
	Normal	68 (50.4)
	Overweight	46 (34.1)
	Obese	21 (15.6)
Family status		
	Unmarried	48 (35)
	Married	74 (54)
	Widowed	4 (2.9)
	Divorced	11 (8)
Children		75 (54.7)
Number of children, median (IQR)		2 (1 - 2)
Educational level		
	Primary school	3 (2.2)
	Middle school	9 (6.6)
	High school	48 (35)
	University	68 (49.6)
	MSc/ PhD	9 (6.6)
Working status		
	Unemployed	29 (21.2)
	Employed	74 (54)
	Pensioner	26 (19)
	Household	8 (5.8)
Financial status		
	Poor	12 (8.8)
	Moderate	76 (55.5)
	Good	49 (35.8)
Place of residence		
	Semi - urban	5 (3.6)
	Rural	29 (21.2)
	Urban	103 (75.2)
Years since diagnosis, mean (SD)		10.8 (7.2)
Under treatment		128 (93.4)
Years under treatment, mean (SD)		5.1 (4.5)
Ever taken cortisone		128 (93.4)
If yes, how long ago, mean (SD)		4.3 (3.7)
Other health problem		0 (0)
Attend physical exercise program		55 (40.1)
If yes, define		
	Gym	14 (25.5)
	Pool	6 (10.9)

Physiotherapy	11 (20)
Other	28 (50.9)
Smoking	61 (44.5)
Daily number of cigarettes, median (IQR)	15 (10 - 20)
Years of smoking, mean (SD)	22.9 (11.8)
Years quit smoking, mean (SD)	8.3 (6.9)
Vitamines	68 (49.6)
MNA total score, median (IQR)	25 (23.5 - 26.5)
MNA levels	
Malnourished	1 (0.7)
At risk of malnutrition	34 (24.8)
Normal nutritional status	102 (74.5)
MedDiet score	29.9 (6.1)

Table 2: MSQOL - 54 scores associated with MedDiet and MNA scores

	Mean (SD)	MedDiet score		MNA total score	
		r	P	rho	P
Physical Health	82.4 (22.1)	- 0.04	0.681	0.25	0.003
Role limitations due to physical problems	86.1 (27.3)	- 0.06	0.453	0.20	0.019
Role limitations due to emotional problems	89.8 (24.1)	0.03	0.765	0.16	0.058
Pain	85 (22.4)	- 0.06	0.459	0.21	0.014
Emotional wellbeing	76.8 (15.4)	- 0.06	0.486	0.35	<0.001
Energy	72.5 (14.8)	0.04	0.683	0.39	<0.001
Health perceptions	33.2 (16.3)	0.04	0.683	0.22	0.010
Social function	88 (19.1)	- 0.13	0.122	0.31	<0.001
Cognitive function	93.6 (13.5)	0.07	0.444	0.27	0.002
Health distress	72.2 (19.7)	0.04	0.614	0.37	<0.001
Sexual function	76.3 (32.6)	- 0.09	0.279	0.25	0.004
Change in health	47.6 (13.5)	- 0.01	0.888	0.14	0.102
Satisfaction with sexual function	66.2 (34.5)	- 0.11	0.216	0.17	0.042
Overall quality of life	71.3 (13.3)	0.04	0.680	0.35	<0.001
MSQOL - 54 Physical Health Composite score	72.6 (16)	- 0.06	0.522	0.35	<0.001
MSQOL - 54 Mental Health Composite score	80.8 (12.6)	0.02	0.840	0.41	<0.001

r: Pearson's correlation coefficient; rho: Spearman's correlation coefficient

Table 3: MSQOL - 54 scores associated with MNA levels

	MNA levels		P+
	Malnourished / At risk of malnutrition	Normal nutritional status	
	Mean (SD)	Mean (SD)	
Physical Health	74.4 (28.6)	85.2 (18.8)	0.012
Role limitations due to physical problems	80 (34.7)	88.2 (24)	0.124
Role limitations due to emotional problems	83.8 (32.7)	91.8 (20.1)	0.089
Pain	77.2 (28.9)	87.7 (19.1)	0.016
Emotional wellbeing	69.5 (19.4)	79.3 (13)	0.001
Energy	66.9 (16)	74.4 (14)	0.009
Health perceptions	28.7 (15.1)	34.8 (16.4)	0.056
Social function	77.6 (27.8)	91.5 (13.4)	<0.001
Cognitive function	91 (15.1)	94.5 (12.8)	0.185
Health distress	63.1 (24.6)	75.3 (16.8)	0.001
Sexual function	70.6 (35.1)	78.2 (31.7)	0.240
Change in health	47.9 (15.3)	47.5 (12.9)	0.908
Satisfaction with sexual function	64.3 (32.2)	66.9 (35.4)	0.699
Overall quality of life	65.8 (14.2)	73.1 (12.4)	0.004
MSQOL - 54 Physical Health Composite score	65.3 (21.2)	75.1 (13.1)	0.002
MSQOL - 54 Mental Health Composite score	74.6 (16.9)	82.9 (10)	0.001

+Mann - Whitney test

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Table 4

Dependent variables	Independent variables	β+	SE++	P
Physical Health	Age	- 5.49	1.70	0.002
	Employed (yes vs no)	10.31	3.35	0.003
	MNA levels (Normal nutritional status vs Malnourished / At risk of malnutrition)	14.43	3.92	<0.001
	Gender (Women vs Men)	12.72	4.07	0.002
Role limitations due to physical problems	Educational level (University/ MSc/ PhD vs High school at most)	15.51	4.32	<0.001
	Age	- 6.26	2.14	0.004
Role limitations due to emotional problems	Educational level (University/ MSc/ PhD vs High school at most)	13.00	3.84	0.001
Pain	Age	- 8.33	1.78	<0.001
	MNA levels (Normal nutritional status vs Malnourished / At risk of malnutrition)	8.68	4.11	0.037
	Attend physical exercise program (yes vs no)	7.48	3.68	0.044
Emotional wellbeing	MNA levels (Normal nutritional status vs Malnourished / At risk of malnutrition)	10.33	2.82	<0.001
	Age	- 3.97	1.24	0.002
	Ever taken cortisone (yes vs no)	- 10.43	4.97	0.038
Energy	Age	- 4.36	1.18	<0.001
	MNA levels (Normal nutritional status vs Malnourished / At risk of malnutrition)	8.47	2.69	0.002
	Ever taken cortisone (yes vs no)	- 10.92	4.74	0.023
Health perceptions	Age	- 3.96	1.35	0.004
	MNA levels (Normal nutritional status vs Malnourished / At risk of malnutrition)	6.29	3.07	0.043
Social function	MNA levels (Normal nutritional status vs Malnourished / At risk of malnutrition)	14.74	3.38	<0.001
	Age	- 5.76	1.49	<0.001
	Ever taken cortisone (yes vs no)	- 14.03	5.95	0.020
Cognitive function	BMI (Overweight vs normal)	- 4.86	2.26	0.033
	BMI (Obese vs normal)	1.56	2.95	0.599
	Educational level (University/ MSc/ PhD vs High school at most)	6.92	2.05	0.001
Health distress	MNA levels (Normal nutritional status vs Malnourished / At risk of malnutrition)	12.66	3.72	0.001
Sexual function	Age	- 14.43	2.48	<0.001
	Smoking (yes vs no)	- 11.01	4.98	0.029
	Employed (yes vs no)	10.51	4.98	0.037
Change in health	Married (yes vs no)	- 5.26	2.27	0.022
Satisfaction with sexual function	Employed (yes vs no)	14.11	5.59	0.013
	Age	- 10.12	2.92	0.001
	Married (yes vs no)	13.55	5.84	0.022
	MNA levels (Normal nutritional status vs Malnourished / At risk of malnutrition)	9.57	2.51	<0.001
	Gender (Women vs Men)	6.28	2.62	0.018
	Age	- 2.42	1.08	0.027
	Ever taken cortisone (yes vs no)	- 9.13	4.30	0.036
MSQOL - 54 Physical Health Composite score	Age	- 6.69	1.21	<0.001
	MNA levels (Normal nutritional status vs Malnourished / At risk of malnutrition)	10.78	2.70	<0.001
	Employed (yes vs no)	6.23	2.37	0.010
	Ever taken cortisone (yes vs no)	- 10.18	4.71	0.032
MSQOL - 54 Mental Health Composite score	MNA levels (Normal nutritional status vs Malnourished / At risk of malnutrition)	9.20	2.20	<0.001
	Age	- 3.27	0.97	0.001
	Ever taken cortisone (yes vs no)	- 9.19	3.87	0.019

+regression coefficient; ++Standard Error

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