The Journal of Frailty & Aging©
Volume 5, Number 3, 2016

ORIGINAL RESEARCH

ASSOCIATION BETWEEN NUTRITIONAL STATUS AND QUALITY OF LIFE IN (PRE)FRAIL COMMUNITY-DWELLING OLDER PERSONS

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Abstract: *Background:* For developed countries, healthy aging is one of the challenges and the number of healthy life years and especially the quality of life (QoL) are important. *Objective:* This study aimed to assess the association between nutritional status and different domains of QoL in (pre)frail community-dwelling elders. *Design:* Baseline data from persons, who participated in a 12-week nutritional and physical training intervention program, conducted from September 2013 - July 2015. *Setting:* (Pre)frail community-dwelling elders living in Vienna, Austria. *Participants:* A total of 83 older persons living at home, 12 men and 71 women (86%) aged 65 to 98 years. *Measurements:* Structured interviews were conducted at participants' homes. Mini Nutritional Assessment® long-form (MNA®-LF) was used to investigate the nutritional status. The QoL domains were assessed with the World Health Organization Quality of Life questionnaires. Simple and multiple linear regression analyses were performed to evaluate the association between nutritional status and QoL domains, adjusted for possible confounders. *Results:* 45% of the participants were at risk of malnutrition and 3% were malnourished. Compared to normal nourished people, persons who had an impaired nutritional status, significantly differed in the QoL domain 'autonomy' with mean (SD) scores of 50.0 (14.9) vs. 57.3 (13.7); p=0.022 and in the QoL domain 'social participation' with scores of 40.1 (13.6) vs. 47.0 (11.2); p=0.014, respectively. According to linear regression analyses, the MNA®-LF score was significantly associated with 'overall QoL' (β=0.26; p=0.016) and the QoL domains 'physical health' (β=0.23; p=0.036), 'autonomy' (β=0.27; p=0.015), and 'social participation' (β=0.28; p=0.013). *Conclusions:* There was a significant association between nutritional status and QoL in elderly (pre)frail community-dwelling people, in particular for the QoL domains 'autonomy' and 'social participation'. However, it remains unclear whether malnutrition was the cause or the consequence, or it was mediated through a third possible factor e.g. the functional status.

Key words: Malnutrition, frailty, quality of life, elderly, living at home.

J Frailty Aging 2016;5(3):141-148
Published online February 9, 2016, http://dx.doi.org/10.14283/jfa.2016.88

Introduction

Elderly persons especially who are older than 80 years will be the fastest growing segment of the population. In the European Union, an important growth forecast from 24 million (5%) in 2010 to 62 million (12%) in 2060 has been reported (1). For developed countries, healthy aging is one of the challenges and both factors, the number of healthy life years and especially the quality of life (QoL) are important. A poor Qol in older persons might reflect health problems relating malnutrition, disability and dependency. Therefore, this relationship should be investigated, prevented and susceptible to improvement (2).

The nutritional status of older persons plays an important role in healthy aging to maintain healthy, functional lives for as long as possible and slowing the progression of chronic disease. In older persons, the most common risk factors for malnutrition are a low socioeconomic status, a reduction in appetite, decrease of the taste sensation, cognitive impairment and dementia, poor dental health and side effects of medications that can further reduce appetite. Furthermore, reduced physical capabilities with impact on activities of daily living is a further risk factor for reduced food intake and consequently malnutrition (3).

A poor nutritional status accelerates the transition from vulnerability to frailty and dependence. QoL can be defined as an individual's perception of their position in life, in the context of the culture and value systems in which they live, in relation to their goals, expectations, standards and concerns. In essence, it is a subjective multidimensional construct reflecting functional status, emotional and social wellbeing, as well as general health (4). Various studies have shown a direct association between poor nutritional status and poor QoL in different populations (5, 6). A recent systematic review (7) indicated that persons at a higher risk of malnutrition are more likely to experience poor QoL. An impaired QoL might be an important determinant of the overall health status of concerned persons and vice versa. Hence, it is important to investigate possible associations between the nutritional status and QoL.

The aim of this study was to assess the association between (pre)frail community-dwelling older persons´ nutritional status with different domains of QoL.

Received November 12, 2015
Accepted for publication December 7, 2015

Methods

Study design

The data for this analysis are baseline measurements from the persons who participated in a randomized controlled trial of a 12-week nutritional and physical activity intervention program, conducted between September 2013 and July 2015 in Austria (8). Participants were included if they were 65 years and older, lived in Vienna, were able to walk, were at risk of malnutrition or malnourished or were prefrail or frail. Exclusion criteria were impaired cognitive function according to the Mini Mental State Examination (MMSE, ≤17 points), planned admission to a nursing home, undergoing chemo- or radiotherapy, comorbidities e.g. insulin treated diabetes mellitus, COPD stage III or IV and chronic kidney insufficiency, and were classified into a nursing level 6 or 7 (8). In Austria, there are seven levels of disability: level 5 to 7 are intended for people whose disability requires 180 hours of care or more. Written informed consent was obtained from all participants who met the inclusion and exclusion criteria.

The study was approved by the ethics committee of the Medical University of Vienna (reference number: 1416/2013) and the local ethics committee of the city of Vienna (reference number: EK13-240-1113). It complies with the Declaration of Helsinki and the protocol was registered at clinicaltrials.gov (Identifier: NCT01991639).

Participant characteristics

Participant characteristics were assessed through structured interviews by well-trained study personnel (nutritional and sport scientists) at the participants' home. Height was obtained using a tape with participants standing upright without shoes. Weight was assessed in light clothing without shoes with a calibrated personal scale (Marsden MS-4203 digital portable scale). Body mass index (BMI) was calculated from measured height and weight as weight (kg) / height^2 (m). BMI was used to examine underweight with 20.0 kg/m^2 for persons <70 years of age and <22.0 kg/m^2 for persons 70 years and older, normal weight with 20.0 or 22.0-24.9 kg/m^2, overweight with 25.0-29.9 kg/m^2 and BMI ≥30.0 kg/m^2 for obesity according to the Consensus Statement of the European Society for Clinical Nutrition and Metabolism (9). Level of education was defined as 'primary' for participants with elementary school or no degree, 'secondary' for those with apprenticeship certificate or a university entrance diploma ('Matura'), and 'tertiary' for participants with education after the university entrance diploma as university degrees. Marital status was categorized as 'living alone', 'widowed' and 'living with others'. The number of oral medication including both prescribed drugs and over-the-counter drugs was assessed. For the evaluation of comorbidities the Charlson Comorbidity Index (CCI) was used. For the assessment of frailty the Frailty Instrument for Primary Care of the Survey of Health, Ageing and Retirement in Europe (SHARE-FI) was used. According to the SHARE-FI calculator, persons were categorized sex-specifically in prefrail and frail (female: >0.315; male: >1.212) (10).

Mini Nutritional Assessment® long-form (MNA®-LF)

Nutritional status was assessed by the long-form of the MNA®-LF (11), an instrument which is validated for the nutritional assessment of persons aged 65 or above. The MNA®-LF consists of two parts: the screening and assessment part. The screening part contains six questions concerning decline of food intake, weight loss in the last three months, acute mobility, disease/ distress, neuropsychological problems, and additionally anthropometric measures (BMI or calf circumference). For this study, calf circumference (CC) was used, which has been shown to be as sensitive as the version with the BMI. CC was measured with a tape in seated position in the left and the right free pendulous lower leg at the strongest circumference. The assessment part consists of twelve questions concerning housing, medicine use, pressure ulcer, dietary intake, and self-rated nutritional and health status. Measurements of mid-arm circumferences were also included. The highest value reachable in the MNA®-LF is 30 points and the persons can be categorized into three nutritional groups: normal nourished (24-30 points), at risk of malnutrition (17-23.5 points) or malnourished (<17 points). MNA®-LF scores demonstrated high sensitivity (98%) and specificity (96%) (12). The MNA questionnaire was developed for self- and interview-administration, in this study it was interview-administered.

World Health Organization Quality of Life – BREF (WHOQOL-BREF)

The WHOQOL-BREF (13) is a self-rated and multi-dimensional instrument with 26 items scored on a five-point Likert scale. The first two questions assess the 'overall QoL', whereas the remaining questions covering four domains: 'physical health' (7 items), 'psychological health' (6 items), 'social relationship' (3 items), and 'environment' (8 items). The items were transformed into domain scores with a range of 0 to 100, as higher scores indicate higher QoL (13). The QoL domain 'social relationship' covers two instead of three items, because of missing values replied to the item 'satisfied with sex life'. The time frame for the assessment is the past two weeks and the German version was used. The instrument was developed for self-administration, but most of the study participants have sufficient ability. Therefore it was interview-administered and the standardized instructions were read out to the participants.

World Health Organization Quality of Life – OLD module (WHOQOL-OLD)

The WHOQOL-OLD module is specific for older persons and it can be used in addition to the generic WHOQOL-BREF (14). In our study we used, four domains: 'sensory abilities', 'autonomy', 'past, present and future activities', and 'social participation'. Like the WHOQOL-BREF, the WHOQOL-

OLD items can be rated on a five-point Likert scale. The domain scores were transformed to a 0-100 scale. Higher scores indicate higher QoL (13). The German version was used and the time frame for assessment was the past two weeks. The questionnaire was also interview-administered.

Statistical analysis

The results are expressed as mean (standard deviation) and median (minimum-maximum) for continuous and as percentages for categorical variables. In order to test for normal distribution, histograms and box plots are used for checking normality visually and the Kolmogorov-Smirnov test was applied as supplementary to the graphical assessment of normality. The 'overall Qol' was treated as categorical variable by performing a median split of lower or higher than 40 points of 'overall QoL' score. It must be noted that according to the rather small sample size in subgroup comparisons, the two subgroups of patients with malnutrition and at risk of malnutrition were merged together in one group called 'impaired nutritional status' (MNA®-LF <23.5 points). Comparisons between the two groups were made using T-test, Mann–Whitney U-test or Chi-square test. The missing data for the WHOQOL-BREF and WHOQOL-OLD were replaced with the series mean according to the WHOQOL guidelines (13). The internal consistency of the QoL domains were determined by a reliability analysis (Cronbach's Alpha). Pearson's correlation coefficients were used to test the relationship between nutritional status and QoL domains. Furthermore, linear regression analyses were carried out to explore the association between the nutritional status, as measured by MNA®-LF score with the QoL domains. In order to assess the strongest indicator for the different QoL domains, multiple linear regression models with stepwise selection including all MNA®-LF items at a p-value threshold of 0.20 were performed for each QoL domain. In all regression models, the adjusting variables age, sex, number of drugs and comorbidities were chosen to control for possible confounding effect on the QoL domains. The statistical assumptions for regression analyses were met in each case. Scatter plots were used to visualize the association between QoL domains and MNA®-LF score. All statistical analyses were performed with IBM® SPSS® Statistics for Windows, Version 22 software (IBM Corp., Armonk, NY, U.S.). P-values <0.05 were considered statistically significant and all tests were two-sided.

Results

The enrollment process for the study consisted of multiple steps. Recruitment was carried out in two different ways: via hospitals and via media. Participants were screened for eligibility in three different Viennese hospitals and after self-selection following a newspaper article and two television reports. Via hospitals, 285 patients were assessed for eligibility in Viennese hospitals. Two hundred and eight (73%) were not meeting the inclusion criteria, 54 (19%) declined to participate and 19 (7%) were excluded due to other reasons for example "no reliable diagnosis" or "unawareness of the future". Via media, 197 potential study participants contacted the study team and they were screened for eligibility. Forty seven (24%) were not meeting the inclusion criteria, 34 (17%) declined to participate and 37 (19%) were excluded due to other reasons for example "no more time or "upcoming operation" etc. In summary 83 participants were included in this analysis.

Twelve community-dwelling men and 71 women aged 65 and above were included in the study. Overall, percentage of missing information was higher for WHOQOL-BREF and lower for WHOQOL-OLD domain scores. The WHOQOL-BREF item 'satisfied with sex life' showed the highest missing information (90%), followed by 'consider your life as meaningful' (4%). The WHOQOL-OLD item 'happy with things to look forward to' showed the highest missing information (11%), followed by, 'satisfied with opportunities to continue achieving' (6%), 'feel in control of future' (4%), 'satisfied with what was achieved in life' (2%), 'negative feelings' and 'people respect freedom' (1%).

More than half of the persons had a primary educational level and most of the participants were living alone. Forty eight percent of the participants had an impaired nutritional status. Furthermore, 63% of the persons who had an impaired nutritional status were frail. The study participants reported lower QoL in all WHOQOL-BREF and WHOQOL-OLD domains with scores ranging between 43 and 75. There was a significant difference between categorized 'overall QoL' score and number of drugs, frailty status and nutritional status (table 1). The 'overall QoL' score ranged between 0 and 80 points and with a median of 40. The characteristics of participants, according to a lower or higher than 40 points of 'overall QoL' score, are presented in table 1.

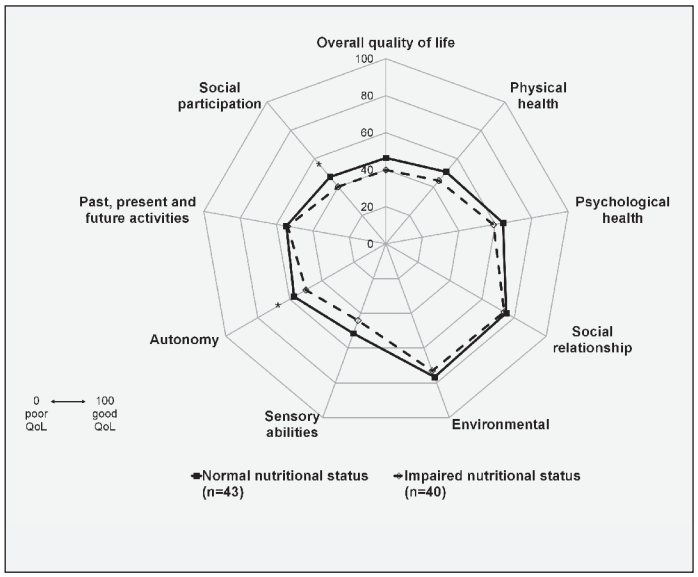
Further, persons who had an impaired nutritional status, compared to normal nourished people, significantly differed in the QoL domain 'autonomy' with mean (SD) scores of 50.0 (14.9) vs. 57.3 (13.7); p=0.022 and in the QoL domain 'social participation' with scores of 40.1 (13.6) vs. 47.0 (11.2); p=0.014 (figure 1). Moreover, internal consistency measured by the Cronbach's alpha for the WHOQOL-BREF items was 0.678 and varied across the domains: 'physical health' (α=0.678), 'psychological health' (α=0.660), 'social relationship' (α=0.574) and 'environment' (α=0.609). Internal consistency for WHOQOL-OLD items was 0.543 and varied across the domains: 'sensory abilities' (α=0.919), 'autonomy' (α=0.640), 'past, present and future activities' (α=0.636) and 'social participation' (α=0.491).

Table 1
Participant characteristics according to the median (=40) overall QoL score

Characteristics	Total (n=83)	Low overall QoL (n=47)	High overall QoL (n=36)	p*
Sex (Female)	86	87	83	0.423
Age (years)	82.6 (8.1)	81.4 (8.4)	84.2 (7.5)	0.115
Educational level				
Primary	53	60	44	0.150
Secondary	35	34	36	
Tertiary	12	6	19	
Living arrangement				
Living with others	17	17	17	0.806
Living alone	83	83	83	
Widowed	52	49	57	
BMI (kg/m^2)	27.1 (4.5)	27.3 (4.6)	26.9 (4.5)	0.724
Underweight (≤20.0 for <70yo and ≤22.0 for ≥70yo)	12	13	11	0.985
Normal weight (>20.0-24.9 for <70yo and >22.0-24.9 for ≥70yo)	21	19	22	
Overweight (25-29.9)	45	45	44	
Obese (≥30)	23	23	22	
Waist circumference (cm)	103.2 (11.7)	103.6 (11.4)	102.7 (12.2)	0.761
Calf circumference (cm)	36.7 (3.6)	36.1 (3.5)	37.5 (3.6)	0.085
Mid-arm circumference (cm)	29.1 (3.9)	29.0 (3.9)	29.3 (4.0)	0.762
Number of drugs	7.7 (4.1)	8.5 (4.3)	6.6 (3.7)	0.032
Charlson Comorbidity Index	1.0 (0-6)	1.0 (0-6)	1.0 (0-6)	0.504
Frailty Score	2.8 (1.1)	3.2 (0.9)	2.4 (1.0)	<0.001
Prefrail	35	19	56	0.001
Frail	65	81	44	
MNA®-LF Score	24.0 (3.3)	23.0 (3.3)	25.3 (2.8)	0.001
Normal nourished	52	40	67	0.026
Impaired nutritional status	48	60	33	
MNA®-LF items				
No decline of food intake	65	64	67	0.377
No weight loss	72	72	72	0.852
Protein consumption				
Milk products (1 portion/ day)	71	68	75	0.491
Legumes or eggs (2 portions/ week)	40	30	53	0.034
Meat or fish (1 portion/ day)	24	26	22	0.727
Fluid intake (≥ 5 glasses/ day)	53	55	50	0.521
Mobility (leaving the house)	63	49	81	0.012
WHOQOL-BREF domains				
Overall quality of life	43.1 (16.4)	32.3 (12.4)	57.2 (8.5)	<0.001
Physical health	47.7 (16.7)	42.3 (14.1)	54.7 (17.4)	0.001
Psychological health	61.7 (15.8)	55.1 (14.1)	70.5 (13.5)	<0.001
Social relationship	74.4 (21.7)	74.2 (22.6)	74.7 (20.8)	0.926
Environment	75.0 (12.3)	71.3 (12.8)	79.7 (9.9)	0.001
WHOQOL-OLD domains				
Sensory abilities	48.0 (22.6)	46.6 (24.0)	49.9 (20.8)	0.517
Autonomy	53.8 (14.7)	49.6 (15.2)	59.3 (12.1)	0.002
Past, present, future activities	54.3 (12.8)	51.4 (12.1)	58.1 (12.9)	0.018
Social participation	43.7 (12.8)	37.8 (11.1)	51.4 (10.7)	<0.001

Note: primary = elementary school or no degree; secondary = secondary school; tertiary = university entrance diploma or higher degrees; BMI = body mass index; MNA®-LF = Mini Nutritional Assessment long-form; data is presented as mean values and standard deviations or median and minimum-maximum or percentages. * Chi2-Test (for ordinal variables), T-test or Mann Whitney-U test (for continuous variables)

Figure 1
Quality of life domain scores in participants with a normal or impaired nutritional status



Association between nutritional status and QoL

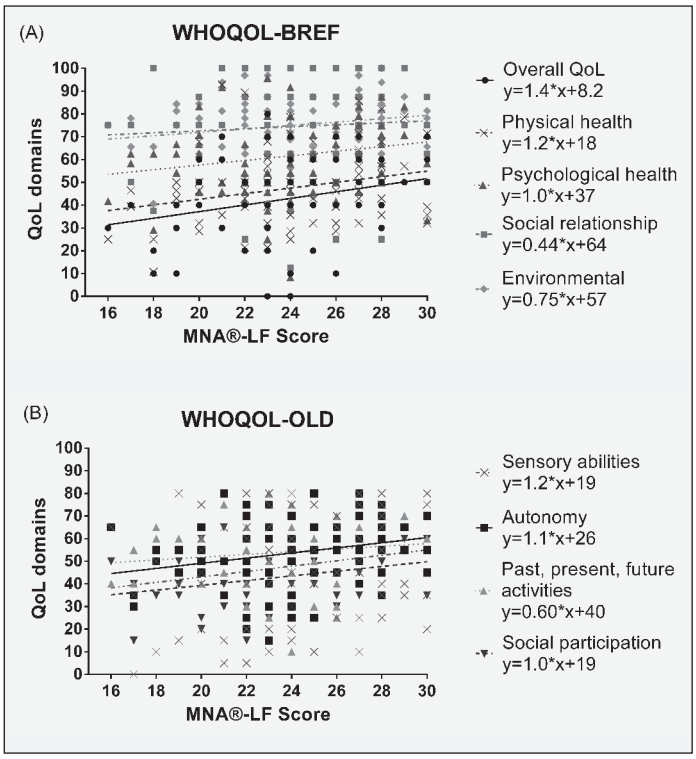
According to Pearson's correlation coefficient, the nutritional status was associated with QoL domains: the MNA®-LF score significantly correlated with 'overall QoL' (r=0.29, p=0.008) and the domain 'physical health' (r=0.25, p=0.022), 'autonomy' (r=0.24, p=0.022) and 'social participation' (r=0.28, p=0.012), but not with the domain 'psychological health' (r=0.21, p=0.058), 'social relationship' (r=0.07, p=0.561), 'environment' (r=0.20, p=0.077), 'sensory abilities' (r=0.18, p=0.107) and 'past, present, future activities' (r=0.14, p=0.194).

According to simple linear regression analyses presented in table 2, the MNA®-LF score contributed to the variability of QoL domains. In the unadjusted and the adjusted models (sex, age, number of drugs and comorbidities) the MNA®-LF score was significantly associated with the following QoL domains: 'overall QoL', 'physical health', 'autonomy', and 'social participation' (table 2 and figure 2). The covariate 'number of drugs' was significantly associated with 'overall QoL' (β=-0.23, p=0.048). Furthermore, the covariate age was significantly associated with the domains 'sensory abilities' (β=-0.34, p=0.002) and 'autonomy' (β=-0.24, p=0.033).

Association between MNA®-LF items and QoL

Table 3 shows the multiple linear regression analyses contained all 18 MNA®-LF items as predictors, also adjusted for age, sex, number of drugs and comorbidities. Individual items of the MNA®-LF, as 'self-rated health status', 'mobility', 'mode of feeding', 'lives independently', 'acute disease/distress and 'self-rated nutritional status', emphasized as significantly strong indicator for QoL domains (table 3).

Figure 2
Associations between the MNA®-LF score and quality of life WHOQOL-BREF and WHOQOL-OLD domain scores



Discussion

The aim of this study was to investigate the association between nutritional status and QoL in (pre)frail community-dwelling older persons. We found a close association between nutritional status and QoL, especially between the QoL domain 'autonomy' and 'social participation'. The MNA®-LF item 'self-rated health' was significantly associated with nearly all QoL domains and was a strong indicator for 'overall QoL' and the QoL domains 'physical health', 'psychological health', 'social relationship', 'environment' and 'autonomy'.

The proportion of participants who were at risk of malnutrition (44%) or were malnourished (4%) was higher as shown in studies by Jimenez-Redondo et al. (15) (27% and 2%) and Shakersain et al. (16) (25% and 2%) with community-dwelling older persons. This could be explained because we only included prefrail or frail persons. Another Austrian study (17) including healthy persons over 70 years showed higher scores in all QoL domains. Nevertheless, the older persons in this study had no chronic or acute disease, whereas in our study, participants were prefrail or frail. There is evidence, that frailty, as a poor physical condition, is associated with poor QoL (18).

Due to the cross-sectional design of the study, no conclusion of causality could be made, and therefore it was not possible to identify which condition was the cause and which was

the consequence. Additionally, a third possibility, e.g. the functional status, may influence the nutritional status and/ or the QoL. Therefore, all three possibilities should be taken into account and will be discussed. The findings from our study suggest that nutritional status was closely associated with QoL domains which underline the importance of considering malnutrition when attempting to improve QoL. This is in concordance with Rasheed and Woods as the MNA® short-form or the Malnutrition Universal Screening Tool (MUST) as global scores of nutritional status were significant predictors of QoL (19). Regarding the vice versa relationship between QoL and nutritional status, there are few explanations. Emotions and especially negative feelings might have effects on food intake. A Canadian study (20) of institutionalized elderly persons showed that emotions are important predictors of food intake. Fatigue and exhaustion may be other factors that might interact with the nutritional status (21). Thus, fatigue and exhaustion seemed to be both the cause and the consequence of malnutrition in elderly persons. If older persons have less energy, it might even happen that they stop eating before they have satisfied their hunger (21). An explanation regarding the third possibility is the functional status which might be a link in the association between the nutritional status and the QoL. Functional status is the ability to carry out specific tasks without physical limitations. The interrelationship between nutritional status and reduced functional capacity has also been established in a recently published study in hospitalized (22) and institutionalized elderly (23). In a previous study (22), a close relationship between nutritional status and frailty status and a strong association between frailty criteria (SHARE-FI) and nutritional status (MNA® short-form items) was observed. The patients who were at risk of malnutrition were more likely to be frail and have an impaired mobility. The finding of Rasheed and Woods (19) was equal to our finding, but with a population of hospitalized older persons.

The MNA®-LF score showed significant associations with 'overall QoL' and the QoL domains 'physical health', 'autonomy' and 'social participation'. Study participants with a higher 'overall QoL' used less number of drugs and had a better nutritional and frailty status. Persons who had an impaired nutritional status had a poorer QoL especially in the QoL domains 'autonomy' and 'social participation' compared to normal nourished persons. This finding is in accordance with previous studies in hospitalized older persons (19), chronically-ill elderly outpatients (24), free-living nonagenarian (25) and community-dwelling older adults (15). Participation and autonomy may directly reflect the potential to influence the QoL and as a consequence the nutritional status. Factors which affect independence are general frailty or falls, infections and other diseases, sudden life events, e.g. the partner passed away (26), or if the person needs help to eat, or the home-delivered meal even for those without eating difficulties (27). Furthermore, sensory functioning change with age and a decline in sensory abilities may affect the independent life, due to the need for assistance (28). Nevertheless, a previous study has shown an association between eating-related disabilities, including loss of appetite and QoL (7). We did not find this association in our study population. Surprisingly, there was no association between QoL and decline of food and fluid intake and weight loss. The MNA®-LF item 'mode of feeding' was a strong indicator for the QoL domain 'physical health' and 'autonomy'. Indeed, our data showed that QoL is affected if a person is unable to eat without assistance or have difficulties to eat. Additionally, the MNA®-LF item 'self-rated health status' might be a good predictor for QoL, as it was a strong indicator for 'overall QoL', the QoL domain 'physical health', 'psychological health', 'social relationship', 'environment' and 'autonomy'. Furthermore, a previous large-scale study reported an association between poor self-rated health and malnutrition in men and women aged 18-79 years (29). Self-rated health reflects physical and psychological well-being of the person (30). Thus the long-form of the MNA® with the 'self-rated health' question, instead of the short-form, might have the advantage to give an indication of the person's QoL. There is also evidence in the literature, that self-rated health obtained by a single question is simple and applicable for clinical and research purpose (30).

This study had several strengths and limitations. An important strength of the present study was the method of investigation. We used valid and reliable instruments to assess the nutritional status and the QoL in older persons. However, there are various instruments assessing nutritional status or QoL and therefore comparisons of studies is difficult. To the best of our knowledge, no instrument exists, which assess both the nutritional status and the QoL in older (pre)frail persons.

As a limitation, the small sample size and the small number of male sex, a common situation when studying an older population, should be considered. Moreover, the cross-sectional design limits the conclusion of causality. Secondly, a potential limitation of this study was the number of participants with missing values. A third limitation was the face-to-face interview. However the interviewers (nutritional and sport scientists) were trained to avoid making suggestions regarding an appropriate response, as this may affect the participant's reply. A further limitation might be some selection bias. The recruitment was carried out in two different ways: via hospitals and via media. On the one hand, the recruitment process via hospitals was not sufficient, because three-quarter of the participants did not fulfill the applied inclusion criteria. On the other hand the recruitment process via media was sufficient. Only one-quarter did not meet the inclusion criteria. In both recruitment processes, about 20% did not participate in the study. Furthermore, potential study participants contacted the study team by themselves or by close relatives. Thus, they were motivated to participate in the study, because they want to perform physical training and nutritional interventions. Hence, the external validity and generalization of the results of the study may be limited.

Table 2
Linear regression analyses for the WHOQOL-BREF and WHOQOL-OLD quality of life domains with the MNA®-LF score

MNA®-LF score	WHOQOL-BREF				WHOQOL-OLD				
	Overall QoL	**Physical health**	**Psychological health**	**Social relationship**	**Environmental**	**Sensory abilities**	**Autonomy**	**Past, present, future activities**	**Social participation**
Model 1 †									
ß	0.29	0.25	0.21	0.07	0.2	0.18	0.25	0.14	0.28
p-value	0.008	0.022	0.058	0.561	0.077	0.107	0.022	0.194	0.012
R^2	0.085*	0.063*	0.044	0.004	0.038	0.032	0.063*	0.021	0.076*
Model 2 ‡									
ß	0.26	0.23	0.18	0.06	0.2	0.19	0.27	0.14	0.28
p-value	0.016	0.036	0.101	0.581	0.075	0.077	0.015	0.219	0.013
R^2	0.170*	0.143*	0.110	0.010	0.122	0.167*	0.140*	0.030	0.094

Note: MNA®-LF = Mini Nutritional Assessment long-form; WHOQOL = World Health Organization Quality of Life; ß = standardized coefficients; † Model 1 unadjusted; ‡ Model 2 adjusted for sex, age, number of drugs and comorbidities; * p-value <0.05

Table 3
Multiple linear regression analyses for the WHOQOL-BREF and WHOQOL-OLD quality of life domains with MNA®-LF items adjusted for sex, age, number of drugs and comorbidities

MNA®-LF items	WHOQOL-BREF									
	Overall QoL (R^2=0.325*)		**Physical health (R^2=0.198*)**		**Psychological health (R^2=0.159*)**		**Social relationship (R^2=0.187*)**		**Environment (R^2=0.189*)**	
	β	**p**	**β**	**p**	**β**	**p**	**β**	**p**	**β**	**p**
Mobility	0.30	0.003	-	-	-	-	-	-	0.23	0.032
Lives independently	-	-	-	-	-	-	-0.34	0.002	-	-
Mode of feeding	-	-	0.23	0.038	-	-	-	-	-	-
Self-rated health status	0.38	<0.001	0.26	0.022	0.28	0.016	0.35	0.003	0.24	0.035

MNA®-LF items	WHOQOL-OLD QoL domains							
	Sensory abilities (R^2=0.194*)		**Autonomy (R^2=0.226*)**		**Past, present, future activities (R^2=0.013)**		**Social participation (R^2=0.183*)**	
	β	**p**	**β**	**p**	**β**	**p**	**β**	**p**
Mobility	-	-	-	-	-	-	0.29	0.009
Acute disease/ distress	0.25	0.017	-	-	-	-	-	-
Mode of feeding	-	-	0.32	0.004	-	-	-	-
Self-rated nutritional status	-	-	0.26	0.017	-	-	-	-
Self-rated health status	-	-	-	-	-	-	0.31	0.007

Note: MNA®-LF = Mini Nutritional Assessment long-form; WHOQOL = World Health Organization Quality of Life; ß = standardised beta coefficient; p-value <0.05; * p-value <0.05

Conclusions

The present study showed a significant association between nutritional status and QoL in frail or prefrail community-dwelling older persons. Especially, there was a close association between nutritional status and 'overall QoL', the QoL domains 'physical health', 'autonomy' and 'social participation'. However, it remains unclear whether malnutrition was the cause or the consequence, or if the association was mediated through a third possibility e.g. the functional status. The single item 'self-rated health' of the long form of the MNA® may predict most of the QoL domains and

therefore the item may allow a rough estimate of the persons' QoL.

Funding and conflicts of interest: The project has been funded by a grant (Life Sciences Call 2012) from the Vienna Science and Technology Fund (reference number LS12-039). This is a non-commercial found and has no role in the design and conduct of the study; in the collection, analysis, and interpretation of data; in the preparation of the manuscript; or in the review or approval of the manuscript. The authors declare that they have no conflict of interest.

Acknowledgments: TED is the principle investigator of the study, designed the study together with KS and CL and prepared the grant application. EL, SH, AK, TED, and KS conducted the research. EL analyzed the data and performed statistical analyses. TED supervised the statistical analysis. EL drafted the manuscript with appreciable input from TED, SH, AK, KS and CL. We thank Maria Luger for language editing. All authors have read and approved the final version of the manuscript.

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