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Malnutrition Is Associated With Impaired Functional Status in Older People Receiving Home Care Nursing Service

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Objective: This study aimed to explore the magnitude and significance of associations among nutritional status, functional status, comorbidities, age, and gender in older adults receiving assistance from the in-home nursing care service.

Method: In this cross-sectional study, 210 home-dwelling persons 65 years or older who received in-home nursing care service were evaluated. Demographic variables, nutritional status, comorbidities, and the dependency levels of activities of daily living were analyzed. To assess the correlation among the factors that influence nutritional status, a theoretical model was developed and adjusted using the path analysis model.

Results: The primary finding is that functional status is directly associated with nutritional status ($\beta = 0.32$; $p < 0.001$) and severity of comorbidities is indirectly associated with nutritional status ($\beta = -0.07$; $p < 0.017$).

Conclusion: The elicited outcomes in this study reinforce the concept that nutritional status is linked with functional status in older adults receiving in-home care nursing service.

Keywords: nutritional status, older adult, nutritional assessment, frailty, comorbididites

INTRODUCTION

According to demographic data, the older adult population has been increasing dramatically in the last 50 years, and it will increase further in the year to come. In 2019, 703 million people were aged 65 years or above in the world. In 2,050, the number is expected to increase to 1.5 billion, meaning that one in every six people worldwide will be aged 65 years or over (1).

Aging is defined as an individual, sequential and cumulative series of physiological changes that occur in an organism over time, resulting in progressive deterioration of functioning, increased vulnerability to disease, and reduced viability (2). Aging is in most people accompanied by multimorbidity and physically debilitating conditions such as sarcopenia, frailty, dementia, and/or malnutrition (3).

Older people may suffer from frailty and malnutrition at the same time. Previous studies have shown a strong association between physical frailty and risk of malnutrition and malnutrition in older adults (4, 5). Thus, a critical agent for healthy aging is an ideal nutritional status. There are several causes for this: reduced appetite and energy expenditure, fluid and electrolyte imbalance, altered levels of cytokines and hormones, delayed gastric emptying, and an impaired sense of smell and taste. Moreover, pathologic changes of aging such as chronic disease, depression, cognitive impairment, multiple morbidities, and polypharmacy play an important role in the complex etiology of malnutrition in older adults (6–8). Hence, studies worldwide have shown the importance of an adequate nutritional status in this critical period of life (9, 10).

Early identification of older adults who are at risk for insufficient caloric intake and nutrient adequacy, termed nutritional risk, or malnutrition, is paramount to maintaining health, independence, quality of life, and longevity (11). The prevalence of malnutrition is reported to be 10–50% in different populations of older people in need of health care services (8, 12). A previous study of older patients receiving domiciliary health care in Norway reported that 41% had dementia and 72% had neuropsychiatric symptoms such as depression, apathy, and anxiety (13). These findings underline that this population is very vulnerable and may consist of older frail people at risk for malnutrition, or even present insufficient caloric intake. Therefore, this study aimed to explore the magnitude and significance of associations among nutritional status, functional status, comorbidities, age, and gender in older adults receiving assistance from the in-home nursing care service in Norway.

METHODS

Study Design and Population

This study is part of the Capturing Acute and Social Care in Dependent Elders (CASCADE), a prospective cross-sectional study on home-dwelling persons 65 years and older who received in-home nursing care service at least once a week in 2016 in a small city (Sandefjord) in the southeast of Norway. Sample size calculation was carried out using information regarding the Norwegian older population receiving home care nursing services ($N = 140,000$ individuals) (14), the confidence level (95%), confidence interval (5%), and the proportion of potential events (prevalence of malnutrition = average 19%) (15). Data were inserted in the Sample Size Calculator, a tool designed by the Australian Bureau of Statistics (16). The estimated sample was established ($n = 237$ participants). To be included, the patients must have had in-home nursing care service for 4 weeks or more to ensure the service's knowledge about the patients' function in a stable situation. From the 588 persons aged >65 years receiving home care nursing in this community, the head nurses continuously selected patients by alphabetical order that fulfilled the inclusion criteria. Patients were not included if they suffered from a terminal illness (life expectancy <2 weeks); if they had a diagnosis of Lewy-body dementia (fluctuations of symptoms make the diagnostic of delirium challenging in these patients); if suffering from chronic disease that has led to need of assistance

from the in-home nursing care service before the age of 65 years; or if need of in-home nursing care service due to substance abuse or psychiatric disease (not dementia) that arise before the age of 65 years adults. Although the sampling calculation established $n = 237$ participants, due to the exclusion criteria aforementioned, in all, 210 older persons were included, of whom 138 (65.7%) were women. The mean age of the entire sample was 84.5 years ($\pm$ 8.3), in women it was 85.9 years ($\pm$ 7.85) and in men, it was 81.4 years ($\pm$ 8.25). The Regional Committee for Ethics in Medical and Health Research and the Data Protection Officer approved the project (2014/1972).

Assessment

The visits in the participants' own homes for collecting data were performed by trained health professionals. The following information was collected: demographic variables and for nutritional status, the full version of the Mini Nutritional Assessment (MNA) was performed. The MNA comprises 18 items grouped in four sections: anthropometric assessment (weight, height, and weight loss); general assessment (lifestyle, medication use, and mobility); dietary assessment (number of meals, food and fluid intake, and autonomy of feeding); and subjective assessment (self-perception of health and nutrition status). Each response has a numerical value and contributes to the final score, which has a maximum value of 30. A score of 24 or higher indicates satisfactory nutritional status; a score of 17 to 23.5 indicates a risk of malnutrition; a score below 17 indicates protein-energy malnutrition (17, 18). Charlson Comorbidity Index (CCI) was calculated according to the comorbidities reported, and the severity scale of CCI was used to classify the severity of comorbidity. The CCI is primarily based on medical record review so as to assign weights for a number of major comorbid conditions. For each condition, the weight is approximately equal to the one-year relative risk of death for that condition. The index score is the total of assigned weights and represents a measure of the burden of comorbid disease (19). The Barthel Index (BI) was applied to measure the functional status. The BI measures the severity of impairment of tasks, such as toilet use, eating, dressing, and climbing stairs. The maximum score is 20 with higher scores indicating better performance and a higher degree of independence in activities of daily living (20).

Statistical Analyses

Continuous variables were summarized as mean and standard deviation (SD). Chi-square, One-way and Two-way ANOVA were used to compare variables of subgroups. We grouped the participants into two age-groups, <85 and ≥85 years old. The 85-year cutoff point was adopted because people aged 85 years and above are considered to be the "oldest old," and this group presents increased risks of malnutrition, multimorbidity, and disability (21). Categorical variables were described by their frequency distribution and chi-square tests were executed for comparison of categorical variables. The following numerical variables were tested for normality: MNA (sk = 0.82; ku = 0.36); Age (sk = −0.38; ku = −0.71), Years of Education (sk = 1.15; ku = 1.57), BI (sk = −1.37; ku = 1.65 and CCI (sk = 0.99; ku = 1.02). Values of skew (sk) > 3 and/or kurtosis (ku)> 7

were considered indicators of a violation of the assumption of normality (22). According to evidence, the nutritional status in older adults is related to a great range of factors, including gender, age, comorbidities, and functional status (23–26). To assess the correlations among the factors that influence nutritional status in the investigated sample, a theoretical model illustrated in **Figure 1** was developed.

The model was adjusted using the path analysis. Direct and indirect effects were estimated using standardized coefficients, adopting a significance level of 0.05. Standardized coefficients with values 0.10–0.29, 0.30–0.49, and >0.50 were interpreted as small, medium, and large effects, respectively (22).

The Bentler's comparative fit index (CFI), the goodness of fit index (GFI), and the Tucker-Lewis index (TLI) were used to assess the quality of the adjustments of the measurement and structural models. These indexes indicate a good adjustment when values >0.90 are reached. The root mean squared error of approximation (RMSEA) was also used, whose value below 0.10 was considered an indicator of reasonable adjustment. In addition, the absolute index χ^2/df was adopted, since this indicates an acceptable adjustment for a value <3 (22, 27–29). The IBM SPSS 23.0 software was used to perform the descriptive analyzes. The software IBM SPSS AMOS 23.0 and R 3.5.0 were used to adjust the model.

RESULTS

The proportion of females was higher than males. Concerning the comorbidities, 29.5 and 22.4% had dementia and heart failure, respectively. A lower CCI score mean was found among women (2.38 ± 1.86), while men presented a higher score (3.09 ± 2.18; $p = 0.014$). According to the MNA score in this study, 15.3% of men and 16.8% of females were malnourished, and most (59.7% of men and 59.1% of women) of the participants were at risk of malnutrition. **Table 1** shows the descriptive statistics and characteristics of the participants, whereas **Tables 2**, **3** show the patients' functional status, the severity of comorbidities, and prevalence of malnutrition and at risk for malnutrition separated by age groups (<85 years vs. ≥85 years). The highest CCI score (3.05 ± 2.18; $p = 0.002$) was seen in the group <85 years. However, there was no difference in the CCI score according to the nutritional status in both age groups ($p = 0.154$). Among the oldest old men, 40% were malnourished, whereas 60% of women of the same age group were malnourished. Among the oldest-old group, 21.7% of the men, and 78.3% of the women were at risk of malnutrition. No significant difference in nutritional status was found between men and women ($\chi^2 = 0.080$; $p = 0.961$) or among the marital status ($\chi^2 = 1,926$; $p = 0.926$).

Figure 2 displays the results of the path analysis, whose adjustment indexes were considered satisfactory: $\chi^2/df = 2.416$; CFI = 0.974; GFI = 0.861; TLI = 0.800; RMSEA = 0.08 (CI90% 0.03–0.13; $p = 0.134$). The variables considered in the adjusted model were Age, CCI and BI. The BI score was the only variable with a medium direct positive and significant effect on the MNA score ($\beta = 0.37$; $p < 0.001$). The CCI score had a small negative direct effect on BI score ($\beta = -0.19$; $p < 0.005$) and
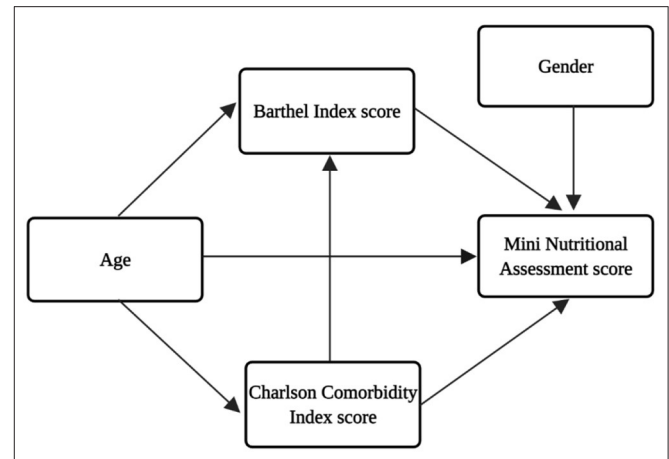

FIGURE 1 | Theoretical model for the interrelationships of the factors that influence nutritional status (MNA score).

TABLE 1 | Sex, years of education, marital status and comorbidities of the participants.

Categorical variables	N	%
Sex		
Male	72	34.3
Female	138	65.7
Years of education		
≤ 10	142	67.6
>10	68	32.4
Age		
<85	101	48.1
≥85	109	51.9
Marital status		
Married/cohabitant	66	31.4
Divorced	31	14.7
Widowed	107	51.0
Single	06	2.9
Comorbidity prevalence		
Myocardial Infarction	38	18.1
Heart failure	47	22.4
Peripheral vascular disease	19	9
Transient ischemic attack	42	20
Dementia	62	29.5
Chronic obstructive pulmonary disease	42	20
Connective tissue disease	33	15.7
Peptic ulcer disease	28	13.3
Mild liver disease	2	1
Diabetes	41	19.5
Diabetes with end-organ damage	9	4.3
Hemiplegia	23	11
Moderate-to-severe renal disease	23	11
Tumor	23	11
Metastatic solid tumor	7	3.3
Leukemia	1	0.5

Values are expressed as n and % for categorical variables.

TABLE 2 | Distribution of participants' characteristics by age groups.

Variables	Age				
	<85 n = 101		≥85 n = 108		
	Mean	SD	Mean	SD	p
Age (years)	77.29	5.37	91.13	3.57	**<0.001**
Years of education	10	3.43	9.514	3.27	0.325
Barthel Index (score)	15.78	4.03	15.84	3.34	0.906
Charlson Comorbidity Index (score)	3.05	2.18	2.21	1.75	**0.002**
Malnourished	3.84	2.47	2.13	1.59	0.154*
At risk of malnutrition	3.09	2.31	2.30	1.87	
Normal nutritional status	2.44	1.45	2.00	1.57	

*Values are expressed as mean and SD for continuous variables. *P-value of the comparison between the nutritional status groups. P-value results are from ANOVA. Bold values indicate statistical significance.*

TABLE 3 | Participants' nutritional status by age according to sex and marital status.

Nutritional status	Variables	n	%	n	%	Significance
		<85 n = 101		≥85 n = 108		
Malnourished	Men	5	26.3	6	40	0.316 χ² = 0,717
	Women	14	73.7	9	60.0	
	Married/cohabitant	6	31.6	5	0.0	0.086 χ² = 4,911
	Divorced	5	26.3	0	0.0	
	Widowed	8	42.1	10	66.7	
At risk of malnutrition	Men	28	50.9	15	21	**0.001** χ² = 11,496
	Women	27	49.1	54	78.3	
	Married/cohabitant	24	43.6	16		**0.013** χ² = 10,825
	Divorced	10	18.2	8	11.6	
	Widowed	18	32.7	43	62.3	
	Single	3	5.5	2	2.9	
Normal	Man	12	44.4	6	25	0.123 χ² = 2,104
	Women	15	55.6	18	75.0	
	Married/cohabitant	8	29.6	7		0.096 χ² = 6,338
	Divorced	7	25.9	1	4.2	
	Widowed	11	40.7	16	66.7	
	Single	1	3.7	0	0.0	

Values are expressed as n and % for categorical variables. Significance according to the Chi-square test. Bold font indicates statistical significance.

age had a negative small effect on the CCI score ($\beta = -0.25$; $p < 0.001$). The CCI score also had an indirect effect on the MNA score ($\beta = -0.07$; $p < 0.017$). This indirect effect was calculated by multiplying the β result of the BI and the MNA β. The other trajectories showed in the theoretical model (**Figure 1**) were not statistically significant and were removed from the adjusted model.

DISCUSSION

The current study examined the associations among nutritional status, functional status, comorbidities, age, and gender in older adults receiving assistance from the in-home nursing care service. The primary finding is that functional status is directly associated with nutritional status and comorbidities are indirectly associated with nutritional status.

Malnutrition is an important public problem observed more frequently in older people compared to the general population (30). This study showed that 15.3% of men and 16.8% of females were malnourished, and most of the participants were at risk of malnutrition. Similarly, Yamamoto et al. (31) also evaluated the nutritional status of older patients (mean age of 84 years old) receiving home care in Japan. According to the MNA evaluation, 18.6 and 49.5% of the participants in the Japanese study were

FIGURE 2 | Adjusted model showing the significant associations among variables.
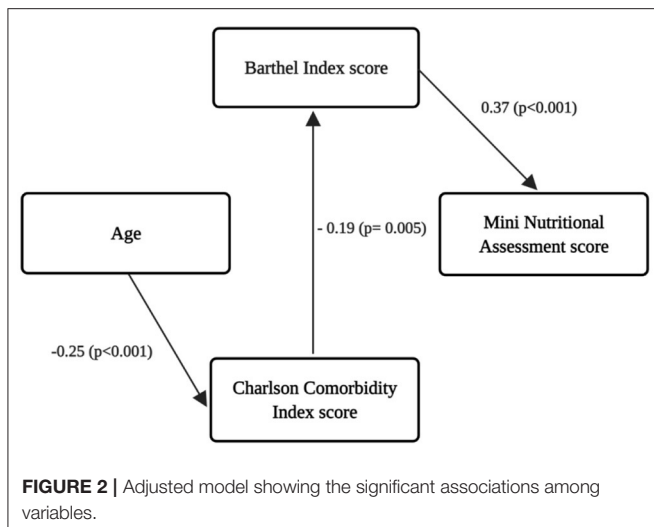
malnourished and at risk of malnutrition, respectively. It has been reported that health, environmental, and social factors or determinants are connected with the risk of malnutrition in older people (32). Especially the widowed older adults are the most malnourished or at the most risk of malnutrition (33). Our study did not find a significant association between marital and nutritional status. However, 62.3% of the widowed oldest-old participants were at risk of malnutrition. According to Besora-Moreno et al. (33), widowhood is related to poor eating habits and less enjoyment of eating.

Although previous research showed a significant correlation between the nutritional status and female gender (34), we did not find any significant relationship between nutritional status and the two age groups of men and women. A similar result was found by Asamane et al. (35) in the United Kingdom. This could be because in general, the women presented fewer comorbidities when compared to men in our study. Moreover, Norway is currently one of the most egalitarian countries in the world according to the Global Gender Gap Index Ranking (36). Thus, it could be assumed that females had fairly equal access to food and therefore eat diets similar to their male counterparts.

Our study also showed an indirect effect of the CCI on the MNA score. The correlation between malnutrition and comorbidities is well-known, and previous studies reported that malnourished older people have higher CCI scores (37, 38). The most prevalent comorbidity found in the participants of the current study was dementia (29.5%). Sanders et al. (39) examined the association of nutritional status and rate of cognitive and functional decline in older adults. The findings showed that malnutrition is associated with more severe symptoms of dementia, and those older people with higher MNA scores would likely experience higher overall cognitive abilities over the course of dementia than those with lower MNA scores.

Furthermore, in this study, age had a direct negative effect on the CCI score. This result diverges from Magdalini et al. (40) study, which shows that there is a significant correlation between older age and increased CCI. However, as our population was receiving in-home nursing services, which is already identified as

a very frail group (41), the younger older people presented more severe comorbidities when compared to the oldest old people. Moreover, the other hypothesis is that the oldest old group could be the fittest due to genetic factors and a lifelong favorable lifestyle. However, we did not explore those other factors.

The CCI score had a direct negative effect on functional status, as expected. Mayoral et al. (42) evaluated older adults with osteoporotic hip fracture in order to verify the influence of comorbidities and cognitive impairment on the physical recovery of those patients, during the first year following the fracture. The results demonstrated that CCI clearly influenced the functional status recovery. Low values of CCI indexes resulted in better BI recovery (42).

Malnutrition has been linked with poor functional status as it is an important contributor toward increased vulnerability for developing negative health outcomes, loss of independence, and mortality (18, 43). Meal preparation and eating disabilities seem to be the main cause of malnutrition in older adults with poor functional status (44). Our study showed a positive and significant effect of functional status on the MNA score. Indeed, these findings are in agreement with previous studies. MNA scores and functional status are positively correlated, and it is shown that both nutritional and functional status worsens with age (38, 45, 46). One possible explanation of how nutritional status affects the functional status could be that low energy and especially low protein intake leads to a loss of muscles and strength and consequent loss of daily function (47). Prevention and treatment of age-related disorders can be done through nutritional interventions, which consider both material and human resources required, such as attendance of qualified nutritionists to routinely conduct effective evaluations and interventions required for maintenance of proper health of older adults receiving home care nursing service.

A strength of this study is the availability of information regarding nutrition and health status which was obtained by standardized questionnaires and geriatric assessment tools. This research, however, has some limitations. First, the cross-sectional design, which limits conclusions regarding causal effects or intraindividual changes. Second, the inclusion of patients in alphabetical order may represent a bias for the participants' selection. Third, the comorbidity assessment was based on information from medical records only. Furthermore, the muscle mass index, physical performance, and polypharmacy were not available to all participants, which make insertion as control variables difficult. Finally, dietary intake was not assessed; therefore, the reasons for malnutrition risk could not be identified.

CONCLUSION

In this study, 15.3% of men and 16.8% of women were malnourished and almost 60% of both sexes were at risk of malnutrition. The elicited outcomes reinforce that severity of comorbidities had a direct impact on functional status, and functional status, in turn, had a direct effect on the nutritional status of older adults receiving in-home nursing care service.

DATA AVAILABILITY STATEMENT

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Regional Committee for Ethics in Medical and Health Research and the Data Protection Officer approved the project (2014/1972). The patients/participants provided their written informed consent to participate in this study.

AUTHOR CONTRIBUTIONS

FUNDING

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