Cognition and nutritional status

- Relationship between cognitive function and nutritional status
in community-living elderly men and women

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Abstract

Background: Elderly persons are at increased risk of both malnutrition and cognitive impairment. The purpose of this study is to investigate the relationship between nutritional status and cognitive function in elderly persons living at home.

Methods: This population based cross-sectional study included 863 women and 594 men aged 65 years and older. Cognitive performance was measured by use of the Mini-Mental State Examination (MMSE). Nutritional status was assessed by The Malnutrition Universal Screening Tool (MUST) and body mass index (BMI), categorised into six groups (< 20.0, $20.0 - 22.4$, $22.5 - 24.9$, $25.0 - 27.4$, $27.5 - 29.9$, ≥ 30.0 kg/m^2).

Results: Medium/high risk of malnutrition was found in 6.7% of the participants, 3.2% of the men and 9.2% of the women (p<0.05). There was no difference in the MMSE sum-scores between men and women. The MMSE sum-scores (median) were similar across the various BMI categories (p-value men = 0.52, p-value women = 0.09). No significant difference in median MMSE sum-score was found between low and medium/high risk categories of malnutrition. In a logistic regression model the MMSE sum-score was associated with the risk of malnutrition, adjusted for age, sex and educational level. The risk of malnutrition with decreasing MMSE sum-score (per unit), was borderline significant, OR 1.10 (95% CI 1.00 – 1.20).

Conclusions: Reduced cognitive function was associated with the risk of malnutrition in community living elderly men and women. The association is relatively weak, but the results indicate that nutritional status should be assessed in elderly persons with cognitive decline. Furthermore, mild cognitive impairment may contribute to increased risk of malnutrition.

Background

Elderly people constitute an increasing proportion of the population and live longer than earlier generations (1). A substantial part of the health resources is used for the treatment of this age group. Cognitive impairment and malnutrition, both affecting a significant number of elderly people, will influence the health burden and challenge the costs for the society.

   A Swedish study of demented elderly persons living in community assisted housing, showed that underweight was prevalent in this group (2). Nutritional intervention studies in elderly with cognitive decline have also been performed. A meta-analysis from 2013 showed that nutritional supplements provided to elderly people were associated with a significant increase in weight, body mass index (BMI) and cognitive test performances (3). A previous study based on data from the Tromsø-study, reported an association between the risk of malnutrition and depressive symptoms in elderly persons (4). Depressive symptoms are often associated with cognitive impairment.

   Obesity and abdominal obesity in particular is a risk factor for reduced cognitive function according to some previous studies (5, 6).

   Previously, the association between deficiency of selected micronutrients and cognitive function has been examined. There is no certain association between cognitive function and vitamin B, vitamin E, vitamin C, folate and beta-carotene, whereas high intake of vegetables and low intakes of saturated fat may have a protective effect with respect to cognitive impairment (7). However, in some studies cognitive impairment is associated with a low level of vitamin B like folic acid, vitamin B-6 and vitamin B-12 (8, 9). A study published in The American journal of clinical nutrition reported that a high level of folate had a preventative effect on cognitive decline, given a normal level of vitamin B-12 (10).

   However, there is still a paucity of population-based research on the relationship between nutrition-related risk and impaired cognitive function according to a major review article in the British Journal of Nutrition (11).

The present study was performed to examine the relationship between the cognitive function and nutritional status of elderly persons living at home.

Methods

Participants

The Tromsø study is a population-based longitudinal study of the inhabitants living in the municipality of Tromsø (12).

The present study is based on data from the sixth Tromsø Study (Tromsø 6) conducted between October 2007 and December 2008 (13). A total of 12 984 community-living men and women aged 30-87 years participated, representing 65,7% of those invited. The analyses are restricted to persons aged 65 years and older, of whom 4017 (65,9%) completed the survey. Nursing home patients were invited, but only 8 attended. The attendance rate declined with increasing age. In the age group 65-69 years, 78% of the invitees attended, shrinking to 40% in the age group 80-89 years.

Information about weight-loss and education was missing for some of the participants (413 persons and 39 persons respectively). MMSE score was available in a representative subgroup of 1566 persons. Consequently, the study population with valid MMSE- and MUST-score was 1457 persons, 863 women and 594 men.

The participants responded on two comprehensive questionnaires including questions about social conditions, lifestyle, employment status, use of different health services and various health aspects. Variables used in the present study were age, sex, marital status and educational level.

For description of the working process see attachment 1.

Design

This is a population-based cross-sectional study.

Assessment of cognition and nutrition
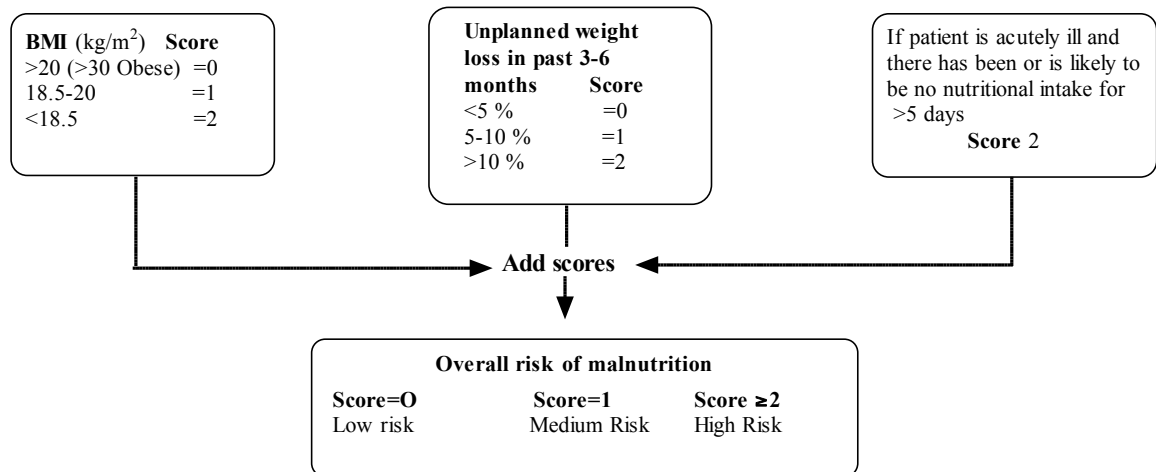
Mini-Mental State Examination

The Mini-Mental State Examination (MMSE) was used to measure cognitive function. This test assesses global cognitive function and is suited to detect cognitive impairment with a degenerative etiology. This test was introduced by Folstein et al in 1975 (14). The MMSE includes cognitive domains such as orientation for time and place, language and visuospatial skills, comprehension, immediate recall of three words and basic motor skills (14). The maximum test sum-score is 30 points (theoretical range). A score above 27 points is considered to be within the normal range. A score below 24 points often corresponds to cognitive impairment consistent with dementia, although a low MMSE-score could also be ascribed to mental disorders.

Body mass index, BMI

Body mass index (BMI) is currently the most used measure of weight status. BMI is defined as weight divided by height squared (kg/ m^2). The Belgian Adolphe Quetlet first described this index in 1832. He found that the BMI score had a good correlation with empirical observations (15). BMI is easy to calculate and extensively used in epidemiological and clinical research. Trained personal measured the height (cm) and weight (kg) of the participants in Tromsø 6 to the nearest decimal. They were lightly dressed and without shoes.

Malnutrition Universal Screening Tool

Malnutrition Universal Screening Tool (MUST) is a validated screening tool assessing nutritional status developed by 'the British Society of Parenteral and Enteral Nutrition' (16). It takes into account BMI, unplanned weight loss the last three to six month and presence of acute illness. The European Society for Clinical Nutrition and Metabolism (ESPEN) recommend to use the 'MUST' tool for nutritional screening in community living elderly persons (17). The acute disease component was defined as if " the patient is acutely ill and there has been or is likely to be no nutritional intake for > 5 days" (16). As the participants had to independently visit a research centre, the acute disease component was set to zero. See figure 1.

BMI (kg/m²)   Score
>20 (>30 Obese) =0
18.5-20   =1
<18.5   =2

Unplanned weight
loss in past 3-6
months   Score
<5 %   =0
5-10 %   =1
>10 %   =2

If patient is acutely ill and
there has been or is likely to
be no nutritional intake for
>5 days
                Score 2

Add scores

Overall risk of malnutrition

Score=O   Score=1   Score ≥2
Low risk   Medium Risk   High Risk

The "Malnutrition Universal Screening Tool" is reproduced here with the kind permission of BAPEN (British Association for Parenteral and Enteral Nutrition). For further information on 'MUST' and management guidelines, see www.bapen.org.uk.

Figure 1. The Malnutrition Universal Screening Tool (MUST)

Other variables

Information on marital status was available and the term single living was defined as those who were single, separated, divorced or widow/ widower. Lower education was defined as primary school only.

Statistics

To compare the baseline variables between men and women the chi-square test or the t-test was used (Table 1). The MMSE sum-score was considered a continuous variable, had a skewness of -1.60 and a standard error of 0.06. The z-value was – 25, which was greater then -1.196. Therefore, the hypothesis of no skewness was rejected. The result from the Kolmogorov-Smirnov statistic also indicated no normality. See figure 2.
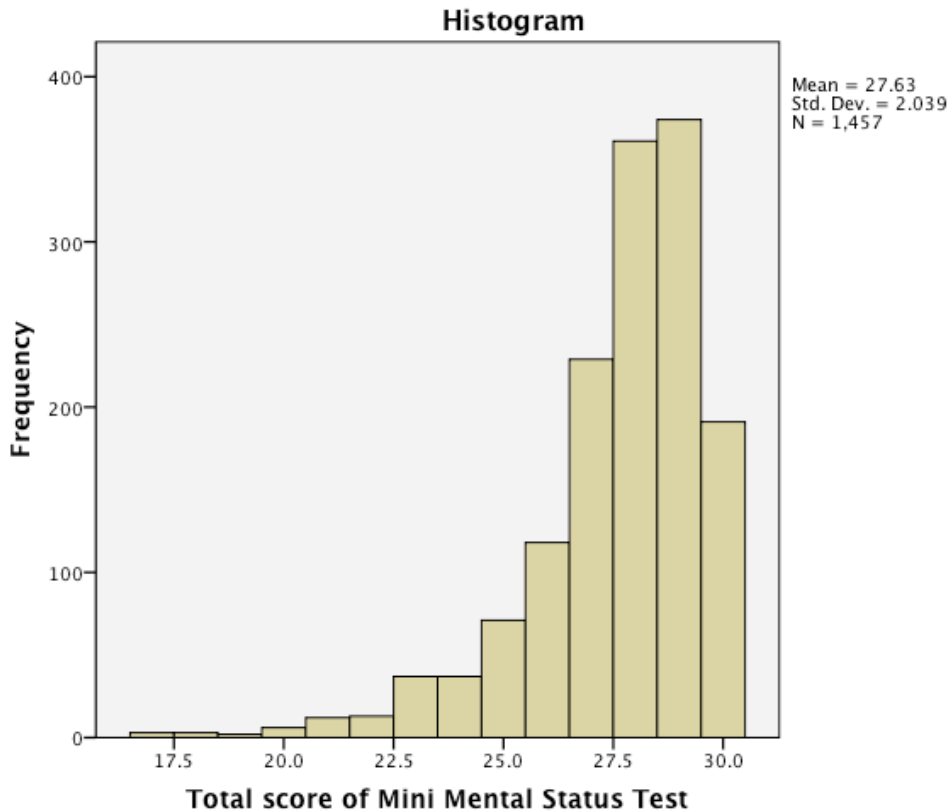
Figure 2. Distribution of MMSE sum-scores. Elderly men and women, The Tromsø Study

The Mann-Whitney U test or the Kruskal-Wallis test was used to test the differences in MMSE sum-scores between the groups. To test the association between the six BMI groups and educational level and marital status the chi-square test was used. See Table 3. The associations between the risk of malnutrition and the MMSE sum-scores was analysed by use of logistic regression. The odds ratio (OR) estimates are adjusted for potential confounders such as age, sex and education level.

A p-value ≤ 0.05 was considered statistically significant.

The analyses were performed using the Statistical Package for Social Science version 21 (SPSS Inc, Chicago, Illinois).

Results

Table 1 presents baseline characteristics of the 594 men and 864 women included in the analyses. The mean age was 71,9 years for men and 71,4 years for women (p = 0.05). Women were more likely to have a lower educational level and to be single living as compared to men. The MMSE sum-score was similar for men and women. Risk of malnutrition (medium and high risk combined) was found in 9.2% of the women (79/ 863) and 3.2% (19/ 594) of the men.

Table 1. Baseline characteristics of participating elderly men and women. The Tromsø Study

	All (n=1457)	**Men** (n=594)	**Women** (n=863)	p-value
Age, years, mean (SD)	71,6 (5,1)	71,9 (5,0)	71,4 (5,2)	0.05[a]
Education				
High (%)	824 (56,6)	423 (71,2)	401 (46,5)	< 0.05[b]
Low (%)	594 (40,8)	157 (26,4)	437 (50,6)	
Single living, (%)	553 (38)	143 (24,1)	410 (47,5)	< 0.05[b]
MMS, mean (SD)	27,6 (2,0)	27,5 (2,0)	27,7 (2,1)	0.05[a]
MMS, median	28,0	28,0	28,0	< 0.05[c]
BMI, mean (SD)	26,9 (4,0)	27,0 (3,2)	26,8 (4,4)	0.28[a]
Risk of malnutrition				
Low (%)	1359 (93,3)	575 (96,8)	784 (90,8)	< 0.05[b]
Medium/high (%)	98 (6,7)	19 (3,2)	79 (9,2)	

[a] t-test, [b] chi-square test, [c] Mann-Whitney U test

BMI and cognitive function

Table 2 shows the calculated MMSE sum-scores distributed on six categories of BMI (median). There was no difference in MMS sum-scores across the various BMI categories.

Table 2: MMSE sum-scores (median) in different categories of body mass index (BMI) in elderly men and women

BMI (kg/m^2)	Men		Women	
	N=593	MMSE	N=862	MMSE
<20	4	27	35	28
20-22.4	29	28	197	28
22.5-24.9	130	28	172	28
25-27.4	199	28	202	28
27.5-29.9	131	28	169	28
≥30	100	28	177	28

There was no statistically significant difference in median MMSE sum-scores across the six BMI-categories (Kruskal-Wallis test, p-value = 0.52 in men and p-value = 0.09 in women).

MMSE sum-scores and the risk of malnutrition

Table 3 shows both the mean and median MMSE sum-scores distributed on the two categories of MUST scores. There was no significant difference in median MMSE sum-scores between the two risk categories of malnutrition.

The difference in mean MMSE sum-scores is less reliable, owing to a skewed distribution of these scores.

Table 3. Total score of Mini Mental Status Test

	Men (n = 594)		p-value	Women (n = 863)		p-value
Risk of malnutrition	Low	Medium/high		Low	Medium/high	
MMS, mean	27,5	26,4	0.01[a]	27,8	27.3	0.01[a]
MMS, median	28,0	27,0	0.21[d]	28,0	28,0	0.10[d]

[a] t-test, [d] Kruskal-Wallis test

The association between the risk of malnutrition and MMSE sum-score was further analysed in a logistic regression model. Decreasing MMSE score was associated with

increased risk of malnutrition (OR 1.10, 95% CI 1.00 – 1.20 per unit decrease in MMSE). The model was adjusted for age and sex. Consequently, a reduction in MMSE score was associated with increased risk of malnutrition. This OR estimate was not significantly changed when educational level was included un the model (OR = 1.10, 95% CI 1.00 – 1.20).

Discussion

In this population-based study of elderly men and women risk of malnutrition was associated with a reduced cognitive test performance. The association was relatively weak and borderline significant with an OR estimate of 1.1. Furthermore, when MMSE scores were compared between the low and medium/high risk of malnutrition and across various BMI categories, no significant differences were found.

   Associations between nutrition and cognitive function have been reported from other studies as well. Most studies have however concentrated on dementia rather than mild cognitive impairment. An Italian study of 130 non-institutionalized demented patients found that patients with mild cognitive impairment had higher mini nutritional assessment scores than patients having suffered from Alzheimer's disease or vascular dementia (18). A study published in European Journal of Nutrition in 2010 reported an inverse association between the intake of fish and vegetables and the cognitive performance scores. The intakes of carbohydrates, polyunsaturated fatty acids, riboflavin and vitamins C, D and E were also greater in the individuals who scored higher on the cognitive tests (19).

   The MMSE sum-scores did not differ across the BMI categories. The low number of men with BMI < 20 (n=4) does not allow statistical comparison with the other categories. Furthermore, using BMI alone as a measure of nutritional status in elderly individuals has some limitations. Due to altered body composition anthropometric measurements may not be appropriate among elderly persons (20). The distribution of fat in the body changes with age, visceral and subcutaneous abdominal fat tend to increase (21). Height is gradually reduced with aging because of decreased thickness of the vertebral body and flattening of the arch of the foot (22). Consequently, BMI increases even if the weight is unchanged. A Swedish longitudinal cohort study with a

25-year follow up found that height, body weight and BMI decreased significantly after the age of 70 years for both sexes (23).

The risk of malnutrition was more prevalent in women (9,2%) than in men (3,2%). In previous studies the risk of malnutrition varied between 2,5% and 21% (4, 24-26), probably explained by differences in sample selection and different measures for malnutrition.

Dementia affects 10-20 % of the population aged 80 years or older (27). MMSE sum-scores in the present study were similar in men and women, as shown in previous studies (28). The diagnostic criteria for various subgroups of cognitively impaired persons will affect the prevalence and incidence greatly (29, 30).

The OR estimate for the association between risk of malnutrition and MMSE sum-score did not change when adding educational level to the model. This is not in accordance with previous studies having reported an association between the educational level and cognitive function (31-34). In these studies the differences could be explained by healthier eating habits in individuals with higher educational level as compared to those with a lower level of education (35). Another explanation could be that individuals with higher educational level have higher scores on the MMSE-test.

Will nutritional support improve cognitive function? This question was addressed in a meta-analysis from 2013 (3). Providing elderly individuals with nutritional supplements was associated with an increased weight and body mass index (BMI) and improved cognition.
However, in a Swedish study oral supplementation provided to elderly persons with a diagnosis of dementia caused weight gain, but did not affect cognitive function (2). The participants in this study already had very low scores on the cognitive tests. Hence, the study population in the Swedish study and the present study are different and unlikely comparable.
Maybe nutritional support influences elderly with mild cognitive impairment better than those with dementia.

The median MMSE sum-score in this study was 28 points for both sexes. Thus, the participants had a relatively good cognitive function. Nevertheless, the present study found a weak association between reduced cognitive function and risk of malnutrition using logic regression.

Strengths and weaknesses

An obvious strength of the present study is the population-based design. However, the response rate may be a concern. In total 65,9% of the invited elderly people attended the study and among the oldest only 40%. Very few nursing home patients attended the study. Acute ill patients did not attend the survey. Thus, selection bias may be present. There are reasons to believe that the elderly men and women who did not participate were in poorer health with more reduced cognitive function and more prone to malnutrition and cognitive impairment than those attending the study. However, it is unlikely that the associations found in this study were weaker in the non-attending elderly men and women.

As this is a cross-sectional study directions of the associations cannot be made. We cannot conclude whether cognitive function is followed by malnutrition or vice versa. But there is a general understanding that optimal cognitive function depends on sufficient nutrition.

Conclusions

The risk of malnutrition is associated with reduced cognitive function in home-living elderly persons. The association is relatively weak, but a consequence of this could be that nutritional screening should be performed in elderly persons with mild cognitive impairment. On the other hand, it is also important to consider an insidious or subjective cognitive impairment in patients presenting with malnutrition.

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Vedlegg til 5.årsoppgave for Karoline Hensrud Sundsvold

Arbeidsprosessen

Arbeidet med oppgaven har vært gjennomført i henhold til prosjektbeskrivelse og arbeidsplan som ble lagt vinter -13.

Jeg begynte å skrive protokoll våren -13. Samtidig med dette gjorde jeg litteratursøk, for det mest i google scholar og pubmed, for å få oversikt over hva som er gjort av tidligere forskning på området samt bygge opp mitt eget referansebibliotek.

Våren/sommeren -13 gikk også med til søknadsprosessen for å få tilgang til data fra Tromsøundersøkelsen. Jeg begynte å sette meg inn i bruk av SPSS sommeren -13 ved hjelp av to ulike lærebøker og youtube.

Med utgangspunkt i protokollen fortsatte jeg skriveprosessen høsten -13. September og oktober brukte jeg til å skrive bakgrunn og lete opp flere referanser. Datamaterialet fra Tromsøundersøkelsen fikk jeg utlevert i oktober -13 og jeg begynte å leke meg med dette i SPSS.

Hadde et møte med veilederne mine i november, da var konklusjonen at jeg var i rute med 5.årsoppgaven. November og desember gikk med til arbeidet med metodekapitlet. Jeg sendte inn foreløpig utkast til veilederne mine i november og fikk tilbakemelding på dette.

Da jeg var ferdig i praksis 1.mars i år var jeg klar til å starte med analysene av datasettet. Jeg hadde flere møter med veilederne mine underveis med dette arbeidet for diskusjon av resultater og analysevei videre. Analysearbeidet gikk mye greiere enn fryktet og jeg var ferdig med dette i løpet av mars, resultatkapitlet skrev jeg samtidig som jeg gjorde analysene. April og mai har gått med til skriving av diskusjon og konklusjon samt grundig språklig gjennomgang av oppgaven.

Jeg har under hele arbeidet med oppgaven fått god hjelp og engasjerte tilbakemeldinger fra veilederne mine Jan-Magnus Kvamme og Torgeir Engstad.