J Nutr Health Aging
Volume 19, Number 4, 2015

BODY MASS INDEX, MINI NUTRITIONAL ASSESSMENT, AND THEIR ASSOCIATION WITH FIVE-YEAR MORTALITY IN VERY OLD PEOPLE

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Abstract: *Objectives:* to investigate the prevalence of malnutrition and the association between Body Mass Index (BMI), Mini Nutritional Assessment (MNA) and five-year mortality in a representative population of very old (>85 years) people. *Design:* A prospective cohort study. *Setting:* A population-based study of very old people in northern Sweden and western Finland, living in institutional care or in the community. *Participants:* Out of 1195 potential participants, 832 were included (mean age 90.2±4.6 years). *Measurements:* Nutritional status was assessed using BMI and MNA and the association of those two variables with five-year mortality was analyzed. *Results:* The mean BMI value for the whole population was 25.1±4.5 kg/m^2, with no difference between genders (P=0.938). The mean MNA score was 22.5±4.6 for the whole sample, and it was lower for women than for men (P<0.001). Thirteen percent were malnourished (MNA<17) and 40.3% at risk of malnutrition (MNA 17-23.5) according to MNA. Also, 34.8% of those with a MNA score <17 still had a BMI value ≥22.2 kg/m^2. A BMI value <22.2 kg/m^2 and a MNA score<17 were associated with lower survival. The association with mortality seemed to be J-shaped for BMI, and linear for MNA. *Conclusions:* Malnutrition according to MNA was common, but a substantial portion of those with a low MNA score still had a high BMI value, and vice versa. The association with mortality appeared to be J-shaped for BMI, and linear for MNA. The MNA seems to be a good measurement of malnutrition in very old people, and BMI might be misleading and could underestimate the prevalence of malnutrition, especially in women.

Key words: MNA, BMI, very old, five-year mortality.

Introduction

Malnutrition is common in old (>65 years) people, with 8% of the free-living elderly in Sweden being classified as malnourished and another 41% at risk of malnutrition (1). The prevalence is even higher in people living in institutional care, with 36% being malnourished and another 48% at risk of malnutrition (2).

Body mass index (BMI) is commonly used for assessing whether subjects are under- and overweight (3) and, although criticized for its inaccuracy in older subjects, is often used to determine when screening for malnutrition should be initiated (4, 5). Both low and high BMI values have been associated with increased mortality, suggesting that the association between BMI and mortality is U-shaped with the most beneficial BMI value being 25-29.9 for old people (6, 7). From the age of 70 however, the association between high BMI values and mortality appears to weaken while the association between low values and mortality remains. This makes the association become decreasingly U-shaped and increasingly J-shaped (8). It also seems as if this changing pattern with increasing age is more pronounced in men compared with women (8).

The Mini Nutritional Assessment (MNA) is a validated and widely used tool (9, 10) for evaluating nutritional status in old people (11). The questionnaire includes 18 questions covering: anthropometric measurements (including BMI), a dietary assessment, questions about the general state, and the self-perception of health and nutritional status (11). A short form of the questionnaire (MNA-SF) has been developed but in this study the full version was used (12-14). A low MNA score has been found to be a strong predictor of long-term mortality in free-living elderly as well as in those living in institutional care (1, 15-17).

Although the associations between BMI, MNA and mortality have been studied previously, studies of long-term mortality among people 85 years or older are uncommon. Therefore, the aim of this study was to investigate the prevalence of malnutrition, assessed by BMI and MNA, and the association between BMI, MNA and five-year mortality in a representative population of very old people in northern Sweden and western Finland.

Methods

Setting and participants

This study used data from the population-based Umeå 85+/GERDA (GErontological Regional DAtabase) study, which consists of data collected in Sweden (six municipalities in the county of Västerbotten) in 2000-2002 and 2005-2007 and in Finland (two municipalities in the county of Pohjanmaa) in 2005-2006. Every other 85 year-old, every 90 year-old, and every individual 95 years and older, were invited to participate. The potential participants were selected from population registers in Sweden (the Swedish National Tax Board) and Finland (the Finnish Population Register Centre). The same selection procedure and inclusion criteria were used

Received March 12, 2014
Accepted for publication May 7, 2014

at all times. Details of the study design have been presented elsewhere (18) but those that are relevant to present research outcomes are discussed below.

To be able to include as many participants in the higher age groups as possible, survivors from the first collection were excluded from the first sample (2000-2002) and included in their current age group in the second sample (2005-2007). Participants who were visited in their homes, including people living in institutional care, and who had a BMI value or a MNA score documented were included in the present study. The final sample included 832 people out of the 1195 potential participants (participation rate 69.6%). Participants were older than non-participants (90.2±4.6 vs. 89.6±4.6 years, P=0.022) but the sex distribution did not differ between the groups (P=0.378). The sample selection is presented in Figure 1.

Procedure

Eligible participants were first contacted by letter with information about the study, then contacted by telephone and asked for informed consent. If cognitive impairment was suspected, a next-of-kin was asked for consent. Participation consisted of a home visit, and included a structured interview and physical assessments. Information was also collected from medical records and relatives and caregivers were asked for supportive information when applicable. This project was approved by the Regional Ethical Review Board in Umeå (§99-326, §05-063M) and by the Ethics Committee of Vaasa Central Hospital (05-87).

Assessments

Participants were weighed to the nearest 0.1 kg with a calibrated portable scale, height was measured to the nearest centimeter with a measuring stick, and BMI (kg/m^2) was calculated. The National Board of Health and Welfare in Sweden has proposed that BMI values <22 kg/m^2, unintentional weight loss, or difficulties in eating should be used as an indication to start an investigation whether old persons are malnourished or not (5). The MNA is a tool for assessing nutritional status in old people. The maximum score is 30 and a score <17 indicates malnutrition, a score between 17-23.5 indicates risk of malnutrition, and a score between 24-30 indicates normal nutritional status (11). It can be used in hospital care as well as in free-living elderly (9, 11, 19, 20).

The Barthel index was used to assess the level of dependence in personal activities of daily living (P-ADL). The maximum score is 20, and 20 indicates independence in P-ADL (21, 22). Cognitive function was measured with the Mini-Mental State Examination (MMSE). The MMSE score ranges from zero to 30 and a score below 24 indicates cognitive impairment (23). Information about diseases was self-reported, retrieved from medical records and when applicable, gathered from caregivers and/or relatives. Diagnoses were based on the assessments, the participants' medical records, and medical history. Dementia and depressive disorders were diagnosed according to diagnostic criteria in the Diagnostic and Statistical Manual of Mental disorders 4th edition (DSM IV) (24). All diagnoses, in both countries, were evaluated by the same experienced geriatrician. Mortality data was collected from the Swedish National Tax Board, the Finnish Population Register Centre, medical records, or death certificates.

Statistical analysis

Analyses were performed in IBM Statistical Package for the Social Sciences (SPSS), version 20.0 for Windows (SPSS Inc,

Table 1
Participants' baseline characteristics. Values shown as numbers (%) or as mean±SD

Characteristics	Women (n=582)	Men (n=250)	p value	85 years (n=290)	90 years (n=306)	≥95 years (n=236)
Women				188(64.8)	209(68.3)	185(78.4)
Age	90.6±4.7	89.3±4.0	<0.001			
Living in Sweden	420(72.2)	189(75.6)	0.305	204(70.3)	234(76.5)	171(72.5)
Free-living	299(51.4)	174(69.6)	<0.001	213(73.4)	184(60.1)	76(32.2)
Living alone	540(93.1)	153(61.4)	<0.001	206(71.0)	264(86.8)	223(94.9)
Education years	6.7±2.2	6.9±2.4	0.290	6.8±1.9	6.9±2.4	6.4±2.5
Current smoker	18(3.1)	12(4.8)	0.239	12(4.2)	12(3.9)	6(2.6)
Depresssive disorders, current	224(39.0)	74(29.6)	0.010	95(32.8)	121(39.8)	82(35.5)
Dementia	257(44.2)	74(29.6)	<0.001	85(29.3)	117(38.2)	129(54.7)
Hypertension	377(64.8)	140(56.0)	0.017	206(71.0)	204(66.7)	107(45.3)
MI, this last year	20(3.4)	7(2.8)	0.635	8(2.8)	13(4.2)	6(2.5)
Heart failure	206(35.5)	68(27.2)	0.020	75(25.9)	105(34.3)	94(40.0)
Stroke	123(21.1)	55(22.0)	0.780	70(24.1)	61(19.9)	47(19.9)
Diabetes mellitus	88(15.1)	36(14.4)	0.789	52(17.9)	49(16.0)	23(9.7)
Malignancy*	51(20.5)	41(7.0)	<0.001	36(12.5)	38(12.4)	18(7.6)
Chronic lung disease	82(14.1)	56(22.4)	0.003	46(15.9)	51(16.7)	41(17.4)
Numbers of drugs taken regularly	7.3±4.2	5.6±3.9	<0.001	6.3±4.0	7.0±4.3	7.0±4.1
MMSE	19.0±8.5	21.9±6.3	<0.001	22.6±6.7	20.0±7.6	16.4±8.8
Barthel ADL-score	14.6±6.5	17.3±4.7	<0.001	17.4±4.9	15.9±5.6	12.4±7.0

* diagnose present today or within five years. SD=Standard deviation. MI=Myocardial infarction. MMSE=Mini-Mental State Examination. ADL=Activities of Daily Living.

Table 2
BMI and MNA for total sample, gender and age groups. Values shown as numbers (%) and mean±SD

BMI	Total (n=803)	Women (n=558)	Men (n=245)	p value	85 years (n=281)	90 years (n=302)	≥95years (n=220)	p value
BMI, mean±SD	25.1±4.5	25.1±4.7	25.1±3.8	0.938	26.1±4.3	24.9±4.4	24.1±4.4	<0.001*
BMI groups								
<22.2 (Q1)	199(24.8)	144(25.8)	55(22.4)		49(17.4)	79(26.2)	71(32.3)	=0.001**
22.2-24.6 (Q2)	196(24.4)	135(24.2)	61(24.9)		65(23.1)	76(25.2)	55(25.0)	
24.7-27.9 (Q3)	207(25.8)	134(24.0)	73(29.8)		81(28.8)	77(25.5)	49(22.3)	
≥28.0 (Q4)	201(25.0)	145(26.0)	56(22.9)		86(30.6)	70(23.2)	45(20.5)	
MNA	**Total (n=782)**	**Women (n=553)**	**Men (n=229)**	**p value**	**85 years (n=265)**	**90 years (n=291)**	**≥95years (n=226)**	**p value**
MNA, mean±SD	22.5±4.6	22.0±4.8	23.8±3.7	<0.001	23.9±3.8	22.6±4.4	20.7±5.1	<0.001*
MNA groups								
<17.0	104(13.3)	94(17.0)	10(4.4)		14(5.3)	33(11.3)	57(25.2)	<0.001**
17.5-23.5	315(40.3)	228(41.2)	87(38.0)		93(35.1)	129(44.3)	93(41.2)	
>23.5	363(46.4)	231(41.8)	132(57.6)		158(59.6)	129(44.3)	76(33.6)	

BMI= Body Mass Index (kg/m²), MNA= Mini Nutritional Assessment, SD=Standard deviation, n=valid answers for BMI and MNA respectively. Analyzed using chi-square tests for categorical variables, and Independent samples T-tests for continious variables. *=analyzed using ANOVA. **= BMI (<22.2 and ≥22.2) and MNA (<17 and ≥17) dichotomized.

Table 3
Distribution of BMI in the MNA groups for the total sample, women, and men. Values shown as numbers (%) and mean±SD

	MNA groups								
	MNA <17			MNA 17.5-23.5			MNA >23.5		
BMI groups	Total (n=92)	Women	Men	Total (n=299)	Women	Men	Total (n=362)	Women	Men
<22.2	60(65.2)	53(64.6)	7(70.0)	84(28.1)	55(25.3)	29(35.4)	50(13.8)	33(14.3)	17(12.9)
22.2-24.6	16(17.4)	16(19.5)	0(0.0)	64(21.4)	47(21.7)	17(20.7)	106(29.3)	66(28.7)	40(30.3)
24.7-27.9	7(7.6)	5(6.1)	2(20.0)	68(22.7)	46(21.2)	22(26.8)	118(32.6)	73(31.7)	45(34.1)
>27.9	9(9.8)	8(9.8)	1(10.0)	83(27.8)	69(31.8)	14(17.1)	88(24.3)	58(25.2)	30(22.7)
BMI Mean ± SD	21.4 ± 4.6	21.2 ± 4.6	22.3 ± 4.9	25.2 ± 4.8	25.5 ± 5.0	24.2 ± 4.1	25.8 ± 3.6	25.9 ± 3.8	25.6 ± 3.3

BMI= Body Mass Index. MNA= Mini Nutriotional Assessment. SD= Standard deviation.

Chicago, IL). Differences between groups were analyzed using chi-square tests for categorical variables, and independent samples T-tests or Analysis of Variance (ANOVA) for continuous variables. Body mass index was divided into groups according to quartiles: Q1: <22.2, Q2: 22.2-24.6, Q3: 24.7-27.9, Q4: ≥28.0 kg/m² and MNA was divided into the established groups <17, 17-23.5, and 24-30. For comparisons between age groups, BMI (<22.2 and ≥22.2) and MNA (<17 and ≥17) were dichotomized. The association between BMI, MNA and five-year all-cause mortality was analyzed using Cox proportional hazards regression analyses. Both unadjusted models and models adjusted for sex and age were performed. A P-value of <0.05 was considered statistically significant.

Results

The participants´ characteristics are presented in Table 1. The mean BMI value was 25.1±4.5 kg/m², and did not differ between women and men (P=0.938), but was lower among the oldest participants (Table 2). The mean MNA score was 22.5±4.6, and the women had a lower mean value compared with the men (22.0 vs. 23.8, P<0.001). Additionally, the mean MNA value was lower among the oldest participants.

According to the MNA cutoffs, 40.3% were at risk of malnutrition and 13.3% were malnourished. More women than men were malnourished (17.0% vs. 4.4%, P<0.001) and the proportion of malnourished people seemed to increase in the older age groups (Table 2). Of those living in institutional care, 25.9% (89/344) were malnourished compared with only 3.4% (15/438) of the free-living individuals (P<0.001). The corresponding figures for being at risk of malnutrition were 54.9% (189/344) and 28.8% (126/438) for institutional care and the free-living respectively (P<0.001). This means that one in five of those in institutional care were classified as well nourished.

BMI and MNA seemed to have a positive correlation

Table 4
BMI quartiles' and MNA groups' association with five-year mortality for the whole sample, unadjusted and adjusted, and when divided into sex and age groups, unadjusted

		BMI			MNA	
		Q1-Q2	Q1-Q3	Q1-Q4	(<17)-(17-23.5)	(<17)-(>23.5)
Unadjusted	HR	0.765	0.563	0.623	0.538	0.257
	95% CI for Exp(B)	0.609-0.961	0.445-0.710	0.494-0.786	0.425-0.680	0.201-0.329
	sig.	0.022	<0.001	<0.001	<0.001	<0.001
Adjusted for sex and age	HR	0.808	0.630	0.739	0.608	0.298
	95% CI for Exp(B)	0.642-1.016	0.498-0.797	0.584-0.936	0.478-0.774	0.229-0.386
	sig.	0.068	<0.001	0.012	<0.001	<0.001
Women, unadjusted	HR	0.840	0.479	0.644	0.497	0.229
	95% CI for Exp(B)	0.640-1.101	0.357-0.644	0.490-0.848	0.385.0.644	0.173-0.303
	sig.	0.207	<0.001	0.002	<0.001	<0.001
Men, unadjusted	HR	0.618	0.726	0.572	0.584	0.272
	95% CI for Exp(B)	0.405-0.945	0.491-1.075	0.369-0.885	0.301-1.135	0.140-0.527
	sig.	0.026	0.110	0.012	0.113	<0.00
85 years, unadjusted	HR	0.928	0.695	0.654	0.512	0.311
	95% CI for Exp(B)	0.571-1.506	0.430-1.121	0.407-1.050	0.274-0.958	0.168-0.575
	sig.	0.761	0.136	0.079	0.036	<0.001
90 years, unadjusted	HR	0.641	0.474	0.703	0.696	0.260
	95% CI for Exp(B)	0.443-0.926	0.324-0.693	0.485-1.018	0.464-1.043	0.168-0.402
	sig.	0.018	<0.001	0.062	0.079	<0.001
≥95 years, unadjusted	HR	0.975	0.752	0.825	0.599	0.381
	95% CI for Exp(B)	0.674-1.411	0.513-1.103	0.555-1.225	0.426-0.844	0.263-0.552
	sig.	0.895	0.145	0.340	0.003	<0.001

BMI= Body Mass Index (kg/m^2). Q=Quartile. Q1= BMI <22.2, Q2= BMI 22.2-24.6, Q3= BMI 24.7-27.9, Q4= BMI ≥28.0 kg/m^2. MNA= Mini Nutritional Assessment. HR= Hazard ratio. CI= Confidence Interval

(r=0.351). However, 34.8% of those with a MNA <17 had a BMI value ≥22.2 kg/m^2 and 13.8% of those with a MNA >23.5 had a BMI <22.2 kg/m^2 (Table 3).

A BMI <22.2 kg/m^2 was associated with higher mortality compared with the other BMI groups, except when compared with a BMI 22.2-24.6 kg/m^2 adjusted for sex and age (Table 4). Additionally, a BMI 22.2-24.6 kg/m^2 was associated with a higher mortality than a BMI 24.7-27.9 for the whole sample (data not shown). Meanwhile, there were no significant differences between a BMI 24.7-27.9 and ≥27.9 kg/m^2 (data not shown). The relationship between BMI and five-year mortality seemed to have a J-shaped appearance for the whole sample when plotted (Figure 2). Sub groups showed more variability, with a BMI <22.2 kg/m^2 associated with higher mortality compared with the other BMI groups in some of the analyses for women, men and 90-year olds but for none of the analysis for 85-year olds and those 95 years or older (Table 4). Furthermore, a BMI <22.2 and 22.2-24.6 kg/m^2 was associated with a higher mortality than a BMI 24.7-27.9 kg/m^2 for women, but not for men and the three age groups separately (data not shown).

A MNA score >23.5 was associated with lower mortality compared with <17 (Table 4), and also compared with 17-23.5 (data not shown), for the whole sample. A MNA score 17-23.5 was associated with lower mortality compared with <17 (data not shown). The relationship between MNA and five-year mortality seemed to have a linear appearance when plotted (Figure 3). In sub group analyses, a MNA score >23.5 was associated with lower mortality compared with <17 (Table 4), and also compared with 17-23.5, for women, men and all age groups separately (data not shown). When comparing MNA scores 17-23.5 with <17, mortality was lower with scores 17-23.5 for women, 85-year olds and those 95 years or older, however not for men and 90-year olds (data not shown).

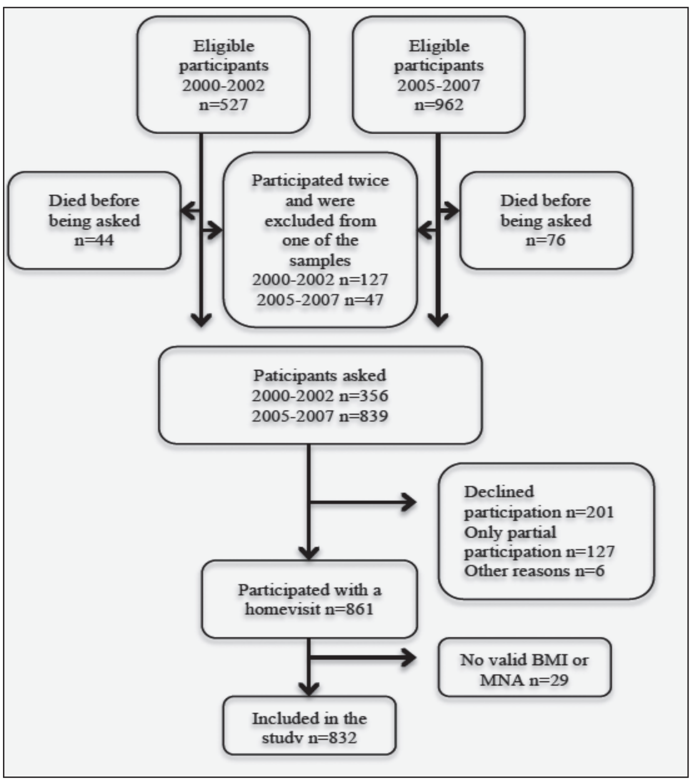
Discussion

Malnutrition, according to MNA, was common in the very old living in northern Sweden and western Finland. It was more common among women, in older age groups, and in people living in institutions. Although BMI and MNA seemed to be correlated (r=0.351), there were individuals with a low MNA score who had a high BMI value and vice versa. The mean BMI value did not differ between women and men, despite the fact that more women were malnourished according to MNA. A BMI value <22.2 kg/m^2 was associated with a higher five year mortality, as was a MNA score <17. The association between BMI and mortality appeared to be J-shaped and the association between MNA and mortality seemed to have a linear appearance.

Malnutrition was more common in the women than in the men, and the women were also older, more dependent in

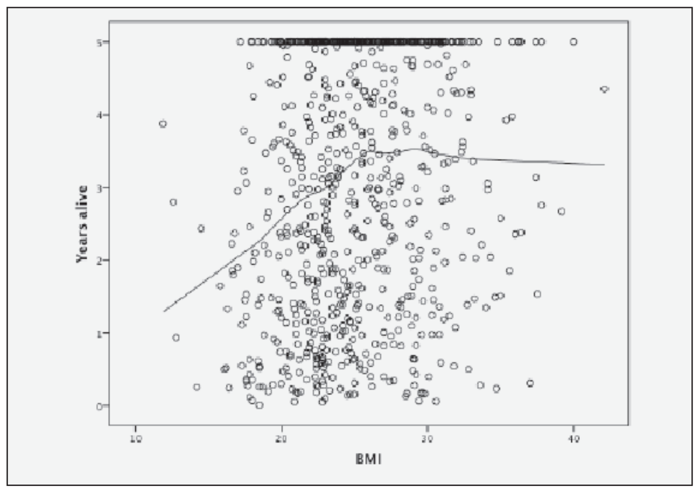
P-ADL, and more often living in institutions compared with the men. Malnutrition has previously been associated with advanced age (25), the level of dependence (11, 26), and with living in institutional care (11). Therefore, the higher prevalence of malnutrition among women in this study might be related to these factors. Also, it was notable that only one in five of those in institutional care were considered to be well nourished according to MNA, although the prevalence is in accordance with a previous study of institutionalized elderly in the north of Sweden (27).

Figure 1
Flow chart of the selection of participants. BMI= Body Mass Index (kg/m^2), MNA= Mini Nutritional Assessment



Although BMI and MNA seemed to be correlated in the present study, one third of those considered malnourished according to MNA had a BMI value >22.2 kg/m^2. This is in agreement with an Australian study where 34% of those at risk of malnutrition had a BMI value of 25 kg/m^2 or more (28). An explanation for these results could be that height decreases with increasing age, resulting in a false high BMI value for old people (29). Another possible explanation could be that there is a continuously loss of muscle mass in older people. This process is called sarcopenia and has many contributing factors, including nutrition. If the sarcopenia is combined with obesity (sarcopenic obesity) the muscle loss could go unnoticed (30-32), suggesting that it might be possible to be inappropriately nourished and still have a normal or even a high BMI. This could mean that malnutrition might be unrecognized in the very old if BMI is used as an indicator for screening, especially if a BMI<22 kg/m^2 is used as a cutoff for when to investigate possible malnutrition (5). While more women were malnourished according to MNA, they did not have a lower mean BMI value compared with the men. It might be that especially very old women are more prone to be malnourished without necessarily having a low BMI and the consequence could be that it is more common that malnutrition is unrecognized in women.

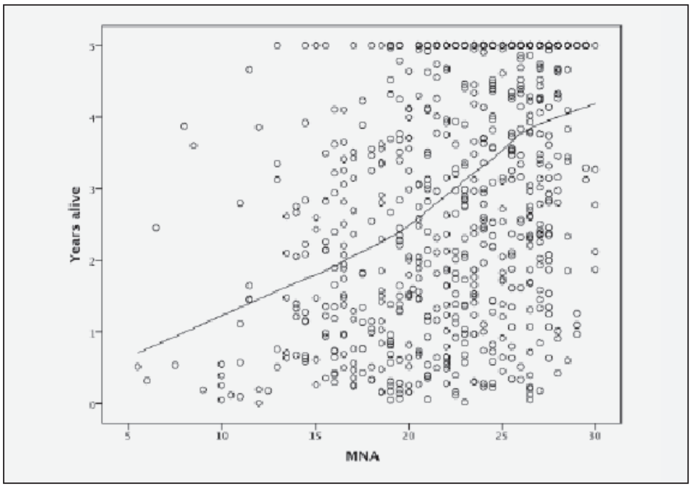
Figure 2
Relationship between BMI and five-year mortality for the whole sample



The association between a low BMI value and long-term mortality is in accordance with previous studies (8, 33, 34). Findings from the present study support previous conclusions that old people benefit from a higher BMI value than what is recommended for adults (7, 35). For the group as a whole, BMI seemed to have a J-shaped association with five-year mortality and these results are also in agreement with a previous study (8).

Malnutrition assessed by MNA was associated with five-year mortality, with the lowest MNA group having the lowest survival and the highest MNA group having the highest survival. The association appeared to be linear, which is in agreement with a previous study (36), and had the same appearance for the whole population as well when divided into gender and age groups. Previous studies have suggested an association between MNA and mortality for old people (1, 15, 36, 37). However, none of these studies had a mean age as high as the present study, and only one of them had a follow-up time of more than five years (15). It has been shown that malnutrition in nonagenarians, assessed by MNA-SF, was not an independent factor of long-term mortality (38, 39). The different results may be caused by the fact that different confounders were considered in these two studies and this study. However, the short form of MNA does not cover areas concerning for example dietary intake and mid arm or calf circumference. So, although the two forms correlate well (13), it is possible that there are specific questions in the full form of MNA that make the assessment of malnutrition in the very old more comprehensive. Or, as proposed in a study of nonagenarians, to add a subjective clinical assessment to the MNA-SF to increase the specificity (40).

Figure 3
Relationship between MNA and five-year mortality for the whole sample



Some strengths of this study were the large sample size of very old people, and that people living in both the community and in institutions were included. No exclusion criteria were used, which meant that those with diseases that are common among the very old were included, which increased the validity of the results. However, some diseases, such as cognitive impairment, could have lead to a poorer ability to participate or may have decreased the accuracy of the results. When cognitive impairment was suspected, caring staff and sometimes relatives assisted in answering questions from the MNA to increase the correctness of the answers. Height and weight were measured by an assessor, which reduced the risk of over/under-estimation that a self-report could cause. A limitation of this study was that only sex and age were considered as confounders when there might be other factors having an impact on mortality. However, the MNA includes questions about mobility, eating independently, living arrangements, number of drugs, recent illnesses, and neuropsychiatric problems. These factors are related to various assessments (e.g. P-ADL, MMSE, GDS-15) and diseases and therefore we adjusted solely for sex and age. Due to the selection procedure with every other 85-year old included, the sample was representative for each age group and not necessarily for the whole sample, but the data still gives a unique perspective on the very old age group.

Conclusions

Malnutrition and risk of malnutrition according to MNA was very common among the very old, but a substantial portion of those with a low MNA score still had a high BMI value, and vice versa. Also, malnutrition was more common among women, but they did not have lower BMI values than men. The association with mortality appeared to be J-shaped for BMI, and linear for MNA, and MNA appeared to be better at separating those with a lower mortality risk compared with BMI. In conclusion, MNA seems to be a good measurement of malnutrition in the very old, and BMI might be misleading and could underestimate the prevalence of malnutrition, especially in women.

Conflict of interest: The authors declare no conflicts of interest.

Ethical standards: The project was approved by the Regional Ethical Review Board in Umeå (§99-326, §05-063M) and by the Ethics Committee of Vaasa Central Hospital (05-87).

References

1. Saletti A., et al., Nutritional status and a 3-year follow-up in elderly receiving support at home. Gerontology, 2005. 51(3): p. 192-8.
2. Saletti A., et al., Nutritional status according to mini nutritional assessment in an institutionalized elderly population in Sweden. Gerontology, 2000. 46(3): p. 139-45.
3. Flegal K.M., et al., Association of all-cause mortality with overweight and obesity using standard body mass index categories: a systematic review and meta-analysis. JAMA, 2013. 309(1): p. 71-82.
4. Cook Z., et al., Use of BMI in the assessment of undernutrition in older subjects: reflecting on practice. Proc Nutr Soc, 2005. 64(3): p. 313-7.
5. The National Board of Health and Welfare, Nutrition for good health and social care (In Swedish)2011.
6. Flicker L., et al., Body mass index and survival in men and women aged 70 to 75. J Am Geriatr Soc, 2010. 58(2): p. 234-41.
7. Soderstrom L., et al., Nutritional status predicts preterm death in older people: A prospective cohort study. Clin Nutr, 2013.
8. Thinggaard M., et al., Is the relationship between BMI and mortality increasingly U-shaped with advancing age? A 10-year follow-up of persons aged 70-95 years. J Gerontol A Biol Sci Med Sci, 2010. 65(5): p. 526-31.
9. Guigoz Y., The Mini Nutritional Assessment (MNA) review of the literature--What does it tell us? J Nutr Health Aging, 2006. 10(6): p. 466-85; discussion 485-7.
10. Guigoz Y., S. Lauque, and B.J. Vellas, Identifying the elderly at risk for malnutrition. The Mini Nutritional Assessment. Clin Geriatr Med, 2002. 18(4): p. 737-57.
11. Cereda E., Mini nutritional assessment. Curr Opin Clin Nutr Metab Care, 2012. 15(1): p. 29-41.
12. Kaiser, M.J., et al., Validation of the Mini Nutritional Assessment short-form (MNA-SF): a practical tool for identification of nutritional status. J Nutr Health Aging, 2009. 13(9): p. 782-8.
13. Rubenstein L.Z., et al., Screening for undernutrition in geriatric practice: developing the short-form mini-nutritional assessment (MNA-SF). J Gerontol A Biol Sci Med Sci, 2001. 56(6): p. M366-72.
14. Kostka J., E. Borowiak, and T. Kostka, Validation of the modified mini nutritional assessment short-forms in different populations of older people in poland. J Nutr Health Aging, 2014. 18(4): p. 366-71.
15. Lundin H., et al., Mini nutritional assessment and 10-year mortality in free-living elderly women: a prospective cohort study with 10-year follow-up. Eur J Clin Nutr, 2012. 66(9): p. 1050-3.
16. Wang J.Y. and A.C. Tsai, The short-form mini-nutritional assessment is as effective as the full-mini nutritional assessment in predicting follow-up 4-year mortality in elderly Taiwanese. J Nutr Health Aging, 2013. 17(7): p. 594-8.
17. Chan M., et al., Nutritional assessment in an Asian nursing home and its association with mortality. J Nutr Health Aging, 2010. 14(1): p. 23-8.
18. von Heideken Wagert P., et al., Health status in the oldest old. Age and sex differences in the Umea 85+ Study. Aging Clin Exp Res, 2006. 18(2): p. 116-26.
19. Vellas B., et al., The Mini Nutritional Assessment (MNA) and its use in grading the nutritional state of elderly patients. Nutrition, 1999. 15(2): p. 116-22.
20. Soini H., P. Routasalo, and H. Lagstrom, Characteristics of the Mini-Nutritional

Assessment in elderly home-care patients. Eur J Clin Nutr, 2004. 58(1): p. 64-70.
21. Sainsbury A., et al., Reliability of the Barthel Index when used with older people. Age Ageing, 2005. 34(3): p. 228-32.
22. Collin C., et al., The Barthel ADL Index: a reliability study. Int Disabil Stud, 1988. 10(2): p. 61-3.
23. Tombaugh T.N. and N.J. McIntyre, The mini-mental state examination: a comprehensive review. J Am Geriatr Soc, 1992. 40(9): p. 922-35.
24. Association A.P., American Psychiatric Association: Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision. Washington, DC: American Psychiatric Association, 2000, 2000.
25. Buffa R., et al., Nutritional status in the healthy longeval population from Sardinia (Italy). J Nutr Health Aging, 2010. 14(2): p. 97-102.
26. Oliveira M.R., K.C. Fogaca, and V.A. Leandro-Merhi, Nutritional status and functional capacity of hospitalized elderly. Nutr J, 2009. 8: p. 54.
27. Carlsson M., et al., Body composition in Swedish old people aged 65-99 years, living in residential care facilities. Arch Gerontol Geriatr, 2009. 49(1): p. 98-107.
28. Winter J., et al., Nutrition screening of older people in a community general practice, using the MNA-SF. J Nutr Health Aging, 2013. 17(4): p. 322-5.
29. Sorkin J.D., D.C. Muller, and R. Andres, Longitudinal change in height of men and women: implications for interpretation of the body mass index: the Baltimore Longitudinal Study of Aging. Am J Epidemiol, 1999. 150(9): p. 969-77.
30. Hwang B., et al., Prevalence rate and associated factors of sarcopenic obesity in korean elderly population. J Korean Med Sci, 2012. 27(7): p. 748-55.
31. Bouchonville M.F. and D.T. Villareal, Sarcopenic obesity: how do we treat it? Curr Opin Endocrinol Diabetes Obes, 2013. 20(5): p. 412-9.
32. Rolland Y., et al., Sarcopenia: its assessment, etiology, pathogenesis, consequences and future perspectives. J Nutr Health Aging, 2008. 12(7): p. 433-50.
33. Nybo H., et al., Predictors of mortality in 2,249 nonagenarians--the Danish 1905-Cohort Survey. J Am Geriatr Soc, 2003. 51(10): p. 1365-73.
34. Lisko I., et al., Body mass index, waist circumference, and waist-to-hip ratio as predictors of mortality in nonagenarians: the Vitality 90+ Study. J Gerontol A Biol Sci Med Sci, 2011. 66(11): p. 1244-50.
35. Dahl A.K., et al., Body mass index, change in body mass index, and survival in old and very old persons. J Am Geriatr Soc, 2013. 61(4): p. 512-8.
36. Persson M.D., et al., Nutritional status using mini nutritional assessment and subjective global assessment predict mortality in geriatric patients. J Am Geriatr Soc, 2002. 50(12): p. 1996-2002.
37. Torma J., et al., Does undernutrition still prevail among nursing home residents? Clin Nutr, 2013. 32(4): p. 562-8.
38. Formiga F., et al., Predictors of 3-year mortality in subjects over 95 years of age. The NonaSantfeliu study. J Nutr Health Aging, 2010. 14(1): p. 63-5.
39. Formiga F., et al., Predictors of long-term survival in nonagenarians: the NonaSantfeliu study. Age Ageing, 2011. 40(1): p. 111-6.
40. Vandewoude M. and A. Van Gossum, Nutritional screening strategy in nonagenarians: the value of the MNA-SF (mini nutritional assessment short form) in NutriAction. J Nutr Health Aging, 2013. 17(4): p. 310-4.