Malnutrition based on Mini Nutritional Assessment and prealbumin in adults aged 80 and over: the BELFRAIL cohort

dr. Veronika Van Acker

Promotor: prof. dr. Jan Degryse
Supervisor: dr. Eralda Hegendörfer

Master of Family Medicine
Masterproef Huisartsgeneeskunde
Academiejaar: [2018 – 2019]

Deze masterproef is een examendocument dat niet werd gecorrigeerd voor eventueel vastgestelde fouten. Zonder voorafgaande schriftelijke toestemming van zowel de promotor(en) als de auteur(s) is overnemen, kopiëren, gebruiken of realiseren van deze uitgave of gedeelten ervan verboden. Voor aanvragen tot of informatie i.v.m. het overnemen en/of gebruik en/of realisatie van gedeelten uit deze publicatie, wendt u tot de universiteit waaraan de auteur is ingeschreven.
Voorafgaande schriftelijke toestemming van de promotor(en) is eveneens vereist voor het aanwenden van de in dit afstudeerwerk beschreven (originele) methoden, producten, schakelingen en programma's voor industrieel of commercieel nut en voor de inzending van deze publicatie ter deelname aan wetenschappelijke prijzen of wedstrijden.

ABSTRACT

Achtergrond: Malnutritie is een globaal probleem bij oudere mensen. Mini-Nutritional Assessment (MNA) is een frequent gebruikte opsporingsmethode van malnutritie. Pre-albumine is een biomarker ter evaluatie van nutritionele status. Er zijn weinig gegevens beschikbaar over malnutritie bij thuiswonende bejaarden ouder dan 80 jaar.
Vraagstelling: Het onderzoeken naar prevalentie van malnutritie in een Belgische cohorte van ouderen boven 80 jaar met hulp van MNA en pre-albumine concentratie en associatie ervan met nadelige effecten.
Methode: BELFRAIL (BF C80+) is een prospectieve, observationele, populatie-gebaseerde cohorte studie van ouderen boven 80 jaar (n=567) in België. De nutritionele status werd geëvalueerd door middel van MNA en pre-albumine niveau. Het overlevingsanalyse en Cox multivariabele regressie analyse werden gebruikt om verband te onderzoeken tussen malnutritie, bepaald door MNA of pre-albumine, met de eerste hospitalisatie (3.0±0.25 jaar opvolging) en sterfte (5.1±0.2 jaar opvolging) met en zonder aanpassing voor mogelijke covariabelen. Cohen`s Kappa coëfficiënt werd gebruikt om de overeenkomst tussen MNA en pre-albumine te berekenen.
Resultaten: 567 ouderen boven 80 jaar werden geincludeerd in het onderzoek: met gemiddelde leeftijd 84.7±3.7 jaar; 211 waren mannen (37.2%). De prevalentie van malnutritie gebaseerd op MNA bedroeg 9.1% (n=52) en 12.7% (n=69) hadden lage levels van pre-albumine (<20mg/dL). De overeenkomst tussen MNA en pre-albumine gebaseerde malnutritie was slecht (K=0.048, p=0.261). Meer vrouwen waren getroffen door malnutritie dan mannen ($p \leq 0.05$). De individu's met malnutritie hadden lager BMI ($p<0.05$). Het cognitief functioneren was meer gestoord voor malnutritie geïdentificeerde door zowel MNA als laag pre-albumine. Ouderen met malnutritie geïdentificeerde door MNA hadden een hogere risico op depressie ($p<0.01$), meer beperkingen in het dagdagelijks leven ($p<0.01$) en waren vaker geïnstitutionaliseerd ($p<0.01$). Lage pre-albumine was geassocieerd met meer inflammatie ($p<0.01$). Verschil in hospitalisatie was niet significant tussen malnutritie groepen gebaseerd op MNA en laag pre-albumine. Individuen met malnutritie gebaseerd op zowel MNA als laag pre-albumine hadden hogere sterfte cijfer; enkel malnutritie gebaseerd op laag pre-albumine was geassocieerd met 5 jaar sterfte na aanpassing voor covariabelen.
Conclusie: De prevalentie van malnutritie gebaseerd op MNA en pre-albumine was laag in onze cohorte van populatie-gebaseerde ouderen boven 80 jaar. Malnutritie was geassocieerd met hogere mortaliteit maar niet met meer hospitalisaties. Verder onderzoek voor het toepassen van MNA en pre-albumine in malnutritie in deze leeftijdsgroep is nodig.

Sleutelwoorden: MNA, prealbumin, Belgium, malnutrition, elderly, prevalence, community-dwelling, mortality, hospitalisation

ABSTRACT

Background: Malnutrition is a common problem among older people. Mini-Nutritional Assessment (MNA) is a frequently used tool for screening for malnutrition. Prealbumin is a biomarker for nutritional evaluation. There is limited data on malnutrition in community-dwelling adults aged ≥80 years.

Objectives: Determine the prevalence of malnutrition in a cohort of Belgian adults aged ≥80 years based on MNA and prealbumin levels and investigate its association with adverse outcomes.

Methods: The BELFRAIL (BF C80+) is a prospective, observational, population-based cohort-study of 80+ elderly (n=567) in Belgium. The nutrition status was evaluated by MNA and prealbumin levels. Survival analysis and Cox multivariate regression were used to investigate the association of malnutrition based on MNA or prealbumin with first unplanned hospitalization (3.0 ±0.25 years follow-up) and mortality (5.1 ±0.2 years follow-up) adjusting for possible covariates. Cohen's Kappa coefficient was used to calculate the agreement of MNA and prealbumin on malnutrition.

Results: The study included 567 elderly ≥80 years: mean age 84.7 ±3.7 years; 211 were men (37.2%). The prevalence of malnutrition using MNA was 9.1% (n=52) and 12.7% (n=69) had low prealbumin (<20mg/dL), the agreement between MNA and prealbumin based malnutrition was very poor (K=0.048, p=0.261). Females were affected by malnutrition significantly more than men ($p \leq 0.05$). For those with malnutrition, the BMI was lower ($p<0.05$). The cognitive functioning was more impaired ($p<0.01$) for both malnutrition identified by MNA and low prealbumin. The malnourished elderly identified by MNA had higher risk of depression ($p<0.01$), more limitations in daily living activities ($p<0.01$) and were more likely to be institutionalized ($p<0.01$). Low prealbumin was associated with high inflammation ($p<0.01$). First hospitalization was not significantly different between the malnutrition groups based on MNA and prealbumin. Those with malnutrition risk based on MNA and prealbumin had significantly higher mortality, but only malnutrition based on prealbumin was associated with 5 years mortality after adjustment for several confounders.

Conclusion: Prevalence of malnutrition risk based on MNA and prealbumin was low in our cohort of community-dwelling adults 80 years and older. Malnutrition based on MNA and prealbumin was associated with mortality but not with hospitalization. The use of MNA and prealbumin to assess malnutrition in this age group should be further researched.

Keywords: MNA, prealbumin, Belgium, malnutrition, elderly, prevalence, community-dwelling, mortality, hospitalisation

Introduction

Almost 650 000 octogenarians are living in Belgium, representing 5.65% of total population, the majority are women (63%) (1). The ageing population is putting upward pressure on public spending in Europe. By 2070 the median life expectancy of both women and men will increase with 4 years, but the working-age population (under 65 years) will decrease (2). The rise of healthcare costs in older adults is associated with co-morbidity and dependence on health workers (3). An important factor related to adverse clinical and functional outcomes in older adults is malnutrition (4). The term 'malnutrition' covers an extended group of nutritional states, including undernutrition (underweight, wasting, stunting), overweight and obesity, vitamin and mineral deficits and excesses (5,6). The fundamental lack of a universally agreed definition hinders the development of diagnostic criteria for routine screening (4,7). A commonly accepted criterion for malnutrition is low body-weight index (BMI) (8). In addition, the Global Leadership Initiative on Malnutrition (GLIM) defines four other criteria for the diagnosis of malnutrition: non-volitional weight loss, reduced muscle mass, reduced food intake and inflammation/disease burden, which were recommended by the European Society for Clinical Nutrition and Metabolism (ESPEN) in 2019 (4).

Already in 1982, Dr. Backer introduced the Nutritional Assessment, today better known as the Subjective Global Assessment (SGA), for evaluating the malnutrition in hospitalized patients admitted to a general surgical ward (9). A collaboration between Switzerland, France and the USA assembled a rapid and simple Mini Nutritional Assessment (MNA) in 1994 (10). Out of ten different screening tools, the Short Form MNA (MNA-SF) appeared to be the most appropriate for the detection of malnutrition in community-dwelling adults greater than 65 years, with a sensitivity of 98% and a specificity of 94% (11). In nonagenarians the MNA turned out to be a very sensitive test for detecting the malnutrition (98%), however the specificity was lower, only 44% (7).

Using the Malnutrition Universal Screening Tool (MUST), the prevalence of malnutrition in Belgium in community-dwelling older adults receiving nursing care is 29% (12). In nursing homes the prevalence increases to 63%, with more mobility problems and a lower activities of daily life score in malnourished older adults (13).

Frequently used blood biomarkers have been evaluated and advised to only be used as a complement to clinical assessment (8). Haemoglobin and cholesterol have proven useful as

biomarkers for malnutrition in the very old (8). The measurement of prealbumin has been used as malnutrition indicator already in 1972 (14). However in case of recent trauma, acute inflammation or infection, prealbumin levels must be interpreted with caution (8,15,16).

MNA is widely used in clinical practice, but to our best knowledge, there exist no comparative studies between MNA and prealbumin in population 80 years and older. In this study we investigate the prevalence of malnutrition based on MNA and prealbumin and its association with adverse outcomes in a prospective cohort of community-dwelling adults aged ≥80 years.

Methods

Study population

We use data from the BELFRAIL study (17): a Belgian prospective, population-based cohort study of women and men 80 years and older. The inclusion period was between November 2, 2008 and September 15, 2009. Exclusion criteria were (i) palliative care, (ii) medical emergency and (iii) severe dementia (MMSE <14). After inclusion the participants were examined by their general practitioner (GP) and received a visit of a trained clinical assistant (CRA) for additional tests and questionnaires. The mortality data was collected until 5 years after inclusion and hospitalization data until 3 years after inclusion (Figure 1).

The Biomedical Ethics Committee of the Université Catholique de Louvain (UCL), Belgium (B40320084685), approved the study protocol. An informed consent was signed by all participants. For more details we refer to the complete protocol of the BELFRAIL study (17).

Malnutrition detection

To evaluate the nutrition status we use MNA, which is a two step procedure: first MNA-SF as screening tool for malnutrition and risk for malnutrition, and full MNA for final assessment of nutritional status (18). The 3-minute MNA-SF screening includes 6 questions regarding (i) decline of food intake, (ii) weight loss in the past 3 months, (iii) mobility, (iv) psychosocial stress or acute disease in the past 3 months, (v) neuropsychological problems and (vi) BMI (19). The maximum score for the screening is 14, where 12 points or higher indicates normal nutritional status, 8-11 points suggests a risk for malnutrition and below 7 points is considered as malnutrition (18). When the participant scores less than 12 points on MNA-SF the full MNA is performed, taking 15 minutes

or less (19). The MNA questionnaire includes 18 items grouped in four sections: anthropometric assessment (weight, height, weight loss); general assessment (lifestyle, medication use, mobility); dietary assessment (number of meals, food and fluid intake, feeding autonomy); and subjective assessment (self-perception of health and nutrition status) (18,20). Based on MNA screening and assessment a participant is classified into three nutritional levels on the basis of scores between 0 and 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 of less than 17 points is considered as malnutrition. In the BELFRAIL cohort the screening MNA was applied to all the participants. In the participants from the northern part of Belgium the MNA assessment was applied only to those with a screening score of 11 or less. In the rest of the cohort, the MNA assessment was applied to all participants no matter the score of the screening part. In this study we consider two groups: those with malnutrition or at risk for malnutrition (if the total MNA score was less than 24) and those not at risk for malnutrition (if total MNA score was 24-30). Participants from the north with an MNA screening score but no MNA assessment score were considered not at risk for malnutrition.

The prealbumin (transthyrin) was measured by the UniCel® DxC 800 Synchron (Beckman-Coulter, Brea, USA) on serum collected after fasting. The reference range between 18-38 mg/dL. The cutoff value of 20 mg/dL was used to dichotomize the population in those at risk/malnourished (< 20mg/dl) and not at risk for malnutrition (≥20 mg/dL).

Other variables

The blood of participants was collected after fasting. To measure the haemoglobin concentrations on whole blood the Sysmex XE-2100 automated haematology analyser (Milton Keynes, UK) was used, with reference range 12-17 g/dL. The ultra-sensitive C-reactive protein (usCRP) was tested on serum using UniCel® DxC 800 Synchron (Beckman-Coulter, Brea, USA), and values >0.3 mg/dL were considered as presence of inflammation.

Multimorbidity was recorded as the sum of the diseases, the disease count (DC). The DC was based on the questionnaire filled in by the GPs in the baseline assessment: angina pectoris, episodes of atrial fibrillation, cardiomyopathy, known valvular disease, myocardial infarct, transient ischaemic attack, stroke, peripheral arterial disease, hypertension, lipid disorders, episodes of decompensated heart failure, osteoporosis, thyroid disease, depression, respiratory disease (chronic obstructive pulmonary disease or asthma), cancer, Parkinson's disease, arthrosis,

arthritis, diabetes, locomotor sequela of stroke and renal failure (17).

The participants' cognitive functioning was assessed by the Mini-Mental State Examination (MMSE) (17). The maximum score is 30, with 24 or less considered as cognitive impairment. The 15-item Geriatric Depression Scale (GDS-15) was used to detect depressive symptoms. A score of five or more indicates risk of depression (17). Physical performance was determined with a battery of tests that consisted of measured times of walking 3 meters and return, sitting and standing from a chair, putting on and taking off a cardigan and maintaining balance in a tandem stand. The summary phyisical performance test (PPT) score ranges from 0-14 (17). Low PPT was defined as being the lowest sex-specific quantile of the total score.

The participants were questioned for difficulties in carrying out six activities of daily living (ADL): climbing stairs, walking 5 min outdoors without resting, getting up and sitting down in a chair, dressing and undressing oneself, using own or public transportation, and cutting one's own toenails. The responses varied from 1 = "No I cannot" to 5 = "Yes, without difficulty", so the summed score ranged between 6 and 30 (17).

Mortality and hospitalisation

Time to all-cause death and first unplanned hospitalization were used as outcomes. The GPs prospectively reported the date and cause of death (until 5.1 ±0.2 years) and hospitalization (until 3.0 ±0.25 years) through detailed follow-up questionnaires.

Statistical analysis

All statistical analyses were performed using SPSS (IBM SPSS version 24.0.0.0). P-values below 0.05 were considered statistically significant. P-P plots were used to evaluate the normality of continuous data. Normally distributed continuous variables are presented as means and standard deviations (SD). The non-normally distributed variables are expressed using the medians and interquartile ranges (IQR). The proportions were expressed as No(%). The differences between groups of continuous variables were analysed using the Student t-test for parametric data and Mann-Whitney U-test for non-parametric data. The categorical variables were compared using the Chi-square test. All-cause mortality until 5 years follow-up and first hospitalization until 3 years follow-up were plotted for the two malnutrition groups based on MNA and prealbumin and log-rank test was used for comparison. Cox proportional hazard regression models were used to

calculate the hazard ratios (HR) with corresponding 95% confidence interval (95%CI) for malnutrition based on MNA and prealbumin, adjusting for potential confounders. Three models were presented: the unadjusted model, model A (adjusted for age, sex and disease count) and model B (model A further adjusted for high usCRP, high GDS-15, low MMSE and low PPT. The group of participants with no risk for malnutrition by MNA or prealbumin were used as reference. Cohen's Kappa coefficient was used to assess the level of agreement between malnutrition risk based on MNA and prealbumin.

Results

Study population

The BELFRAIL cohort included 567 participants, of whom 37.2% were male. The mean age was 84.7 ±3.7 years and only 10.1% were institutionalized (Table 1). The participants at risk for malnutrition by both MNA (n=52; 9.1%) and prealbumin (n=69; 12.7%) were more often women, had lower BMI, and higher mortality (Table 1). Those at risk for malnutrition by MNA had lower ADL-score, lower MMSE, higher GDS-15 score and were four times more likely to be institutionalized compared to the group without risk for malnutrition (Table 1). The group with low prealbumin had higher levels of usCRP compared to the normal prealbumin group (Table 1).

Only 9 participants were identified at risk/malnourished by both MNA and prealbumin (Table 3). The agreement using Cohen's Kappa was very poor and not significant (K=0.048, p=0.261) (Table 3).

Survival analysis

Hospitalization

Approximately half of the participants (50.8%) was hospitalized at least once during the period of 3 years after inclusion. There was no significant difference in time to first hospitalization between neither the MNA-groups (log rank test p=0.164) and prealbumin groups (log rank test p=0.056), based on the Kaplan-Meier curves (Figure 2).

Mortality

At the end of 5 years follow-up after inclusion, 242 participants died (42.7%). The Kaplan-Meier

curves display a significant difference in survival between at risk/malnourished group versus not at risk MNA groups (log rank test p<0.001). For mortality, those with low prealbumin died earlier (log rank test p=0.001). The hazard ratio for mortality was significantly higher in the unadjusted at risk/ malnourished MNA group versus not at risk group (p<0.01; HR 2.22; 95%CI=1.55-3.18). After adjustment for age, sex and multimorbidity (model A), the significance remained (p<0.01; HR 1.87; 95%CI=1.29-2.70). In model B (adjusted for age, sex, multimorbidity, high usCRP, low MMSE, low PPT, high GDS-15) the HR was not statistically significant (p=0.11; HR 1.43; 95%CI=0.93-2.19). Those with malnutrition based on prealbumin had high HR even after adjustments for covariates. A complete overview of the Cox regression analysis can be found in Table 2.

Discussion

In this study we focused on the prevalence of malnutrition and its effect on negative outcomes in a Belgian cohort of adults 80 years and older using MNA and prealbumin as screening tools. There is only a small number of articles available about malnutrition in populations older than 80 years, in contrast to populations 65 years and older (7,21). The prevalence of malnutrition (9.1%) in our study with community dwelling participants is lower than in other publications where the prevalence ranges from 24.7% up to 57%, depending on the setting (higher in hospitalized, institutionalized and older individuals) (7,12,22–24). Additionally, we can conclude from our data that malnutrition is associated with higher mortality rates in community-dwelling adults 80 years and older, which supports already existing data (25). The same finding was seen in a Swedish 11-year long population-based study, which calculated that the median age of death was 3 years shorter for malnourished (24). For shorter periods, malnutrition is also associated with increased one-year mortality in a cohort of hospitalized geriatric patients (26). In our study, the participants at risk for malnutrition or with low prealbumin were not more hospitalized than those without risk for malnutrition or normal prealbumin. This supports an existing study, which uses MUST as malnutrition indicator (12). In contrast, a large population-based sample of community-dwelling seniors aged 65 or older demonstrated higher hospitalization rates in malnourished individuals (27). This discrepancy in findings may be explained by a difference in settings, aged 65 or older versus aged 80 or older, the survivors of their generation.

Further, better nutritional status has a positive effect on quality of life (26,28). In our study we saw that a lower ADL and MMSE score and higher GDS-15 score in the at risk/malnourished group can lead to impairment in daily functioning, and therefore a lesser quality of life. The women had

higher risk of malnutrition, as already was mentioned in previous literature (7). Other studies did not support same findings (12,26).

Interpretation of prealbumin concentrations is not easy: it decreases in case of infection, liver dysfunction and overhydratation; it increases in case of renal dysfunction, corticosteroid therapy or dehydratation (15,16). However, prealbumin is a valuable tool to identify malnutrition in non-acute settings (8). In our study we used the common 20 mg/dL prealbumin as cut-off value for malnutrition, even though there is still discussion on this topic (8). In our cohort, the individuals with low prealbumin had a significantly higher usCRP and lower haemoglobin. After modification for several confounders (including inflammation), low prealbumin was still independently associated with 5 years mortality while the MNA based malnutrition lost statistical significance after adjustment.

The very poor level of agreement between prealbumin and MNA based malnutrition shows that they identify different groups of patients. This is not surprising as MNA is based on self-report/assessment and anthropometric measurements, while prealbumin is a blood biomarker. Further studies on prealbumin and other blood biomarkers and their role in malnutrition, especially in the group of 80 years or older, are needed.

Our study has some limitations. As the data was collected between 2008 and 2009, our findings are possibly belated. However, it is a prospective study of a representative community-dwelling population aged 80 years and older in Belgium, with comprehensive assessment that allowed adjustment for several confounders such as multimorbidity, physical performance, affective and cognitive status, and inflammation, as well as assessment of 5 years mortality and 3 years hospitalization.

As the number of those identified as (strictly) malnourished based on the MNA was low (n=8) they were combined together with those at risk for malnutrition in one group. Not all participants received full MNA assessment, but all in the at risk/malnourished group did.

Conclusion

In a community-dwelling cohort of adults 80 years and older in Belgium, risk of malnutrition based on MNA or prealbumin had low prevalence, and only malnutrition based on prealbumin was independently associated with mortality at 5 years follow-up. The prevalence is higher in women. A universal definition for malnutrition is lacking and there is no golden standard screening method. However, the MNA is a well-known and widely used screening tool for malnutrition in

adults 65 years and older. There is need for more studies where MNA is being used in population 80 years and older. Prealbumin is an easy biomarker but must be interpreted with caution, and there is discussion going on the cut-off value for prealbumin. Early and systematic screening for malnutrition can possibly reduce hospitalizations and mortality, and also improve quality of life.

ACKNOWLEDGEMENTS

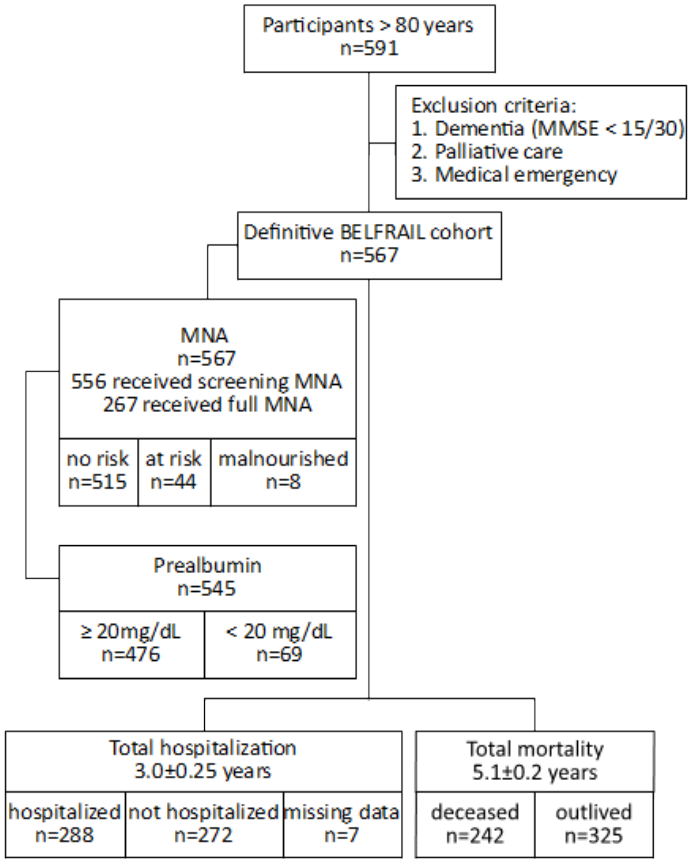
First and foremost, I definitely want to thank Prof. Degryse. Besides his statistical expertise and creative ideas, he proved to be a patient, supportive and encouraging promotor. I also greatly appreciate the help of dr. Hegendörfer for generously making time to discuss this work and giving valuable feedback.

References

1. Loop van de bevolking van België 2016-2060 [Internet]. Available from: http://statbel.fgov.be/nl/modules/publications/statistiques/bevolking/downloads/loop_van_de_bevolking_2016-2060.jsp
2. European Commission. The 2018 Ageing Report: economic and budgetary projections for the EU Member States (2016-2070). Vol. 2, European Economy. 2018. 27 p.
3. Bock J-O, König H-H, Brenner H. Associations of frailty with health care costs - results of the ESTHER cohort study. BMC Health Serv Res. 2016;16(1):128.
4. Cederholm T, Jensen GL, Correia MITD, et al. GLIM criteria for the diagnosis of malnutrition – A consensus report from the global clinical nutrition community. J Cachexia Sarcopenia Muscle. 2019;10(1):207–17.
5. Cederholm T, Bosaeus I, Barazzoni R, et al. Diagnostic criteria for malnutrition - An ESPEN Consensus Statement. Clin Nutr. 2015;34(3):335–40.
6. Malnutrition WHO key facts [Internet]. [cited 2019 Aug 1]. Available from: https://www.who.int/news-room/fact-sheets/detail/malnutrition
7. Vandewoude M, Van Gossum A. Nutritional screening strategy in nonagenarians: The value of the MNA-SF (Mini Nutritional Assessment short form) in NutriAction. J Nutr Heal Aging. 2013;17(4):310–4.
8. Zhang Z, Pereira SL, Luo M, et al. Evaluation of blood biomarkers associated with risk of malnutrition in older adults: A systematic review and meta-analysis. Vol. 9, Nutrients. 2017.
9. Baker JP, Desky AS, Wesson DE. Nutritional Assessment; a comparsion of clinical judgement adn objective measurment. BMJ. 1982;306:969–72.
10. Guigoz Y, Vellas B, Garry PJ. Mini Nutritional Assessment: a practical assessment tool for grading the nutritional state of elderly patients. Facts Res Gerontol. 1997 Oct;(suppl 2):15–60.
11. Phillips MB, Foley AL, Barnard R, et al. Nutritional screening in community-dwelling older adults: A systematic literature review. Vol. 19, Asia Pacific Journal of Clinical Nutrition. 2010. p. 440–9.
12. Geurden B, Franck Mpsych E, Lopez Hartmann M, et al. Prevalence of "being at risk of malnutrition" and associated factors in adult patients receiving nursing care at home in Belgium. Int J Nurs Pract. 2015;21(5):635–44.
13. Vandewoude MFJ, van Wijngaarden JP, De Maesschalck L, et al. The prevalence and health burden of malnutrition in Belgian older people in the community or residing in nursing homes: results of the NutriAction II study. Vol. 31, Aging Clinical and Experimental Research. Springer International Publishing; 2019. p. 175–83.
14. Ingenbleek Y, De Visscher M, De Nayer P. Measurement of prealbumin as index of protein-calorie malnutrition. Lancet. 1972 Jul;300(7768):106–9.
15. Beck F, Rosenthal T. Prealbumin: A Marker for Nutritional Evaluation - American Family Physician. Am Fam Physician. 2002;65(8):1575–9.
16. Keller U. Nutritional Laboratory Markers in Malnutrition. J Clin Med. 2019;8(6):775.
17. Vaes B, Pasquet A, Wallemacq P, et al. The BELFRAIL (BFC80+) study: a population-based prospective cohort study of the very elderly in Belgium. BMC Geriatr. 2010 Dec 17;10(1):39.
18. Guigoz Y, Lauque S, Vellas BJ. Identifying the elderly at risk for malnutrition. Clin Geriatr Med. 2002;18(4):737–57.
19. Rubenstein LZ, Harkar JO, Salva A, Al. E. Screening for Undernutrition in Geriatric Practice: Developing the Short-Form Mini-Nutritional Assessment (MNA-SF). Journals Gerontol Ser A Biol Sci Med Sci. 2011;56(6):366–72.
20. Nestlé - Nutrilon Institute. Mini Nutritional Assessment. Available from: https://www.nestlehealthscience.nl/nl/services/screening-tools/documents/mna_long_nl_interactive.pdf
21. Vanderwee K, Clays E, Bocquaert I, Gobert M, Folens B, Defloor T. Malnutrition and associated factors in elderly hospital patients: A Belgian cross-sectional, multi-centre study. Clin Nutr [Internet]. 2010;29(4):469–76. Available from: http://dx.doi.org/10.1016/j.clnu.2009.12.013
22. Kaiser MJ, Bauer JM, Rämsch C, et al. Frequency of malnutrition in older adults: A multinational perspective using the mini nutritional assessment. J Am Geriatr Soc. 2010;58(9):1734–8.
23. Groot CPGM De, Staveren WA Van. Undernutrition in the European SENECA studies. Clin Geriatr Med. 2002;18(4):699–708.
24. Shakersain B, Santoni G, Faxén-Irving G, et al. Nutritional status and survival among old adults: an 11-year population-based longitudinal study. Eur J Clin Nutr. 2016 Mar 8;70(3):320–5.
25. Söderström L, Rosenblad A, Adolfsson ET, Saletti A, Bergkvist L. Nutritional status predicts preterm death in older people: A prospective cohort study. Clin Nutr. 2014 Apr;33(2):354–9.
26. Hernández-Galiot A, Goñi I. Quality of life and risk of malnutrition in a home-dwelling population over 75 years old. Nutrition [Internet]. 2017 Mar;35:81–6. Available from: https://linkinghub.elsevier.com/retrieve/pii/S0899900716302362
27. Ramage-Morin PL, Gilmour H, Rotermann M. Nutritional risk, hospitalization and mortality among community-dwelling Canadians aged 65 or older. Heal Reports. 2017;28(9):17–27.
28. Beck AM, Christensen AG, Hansen BS, et al. Multidisciplinary nutritional support for undernutrition in nursing home and home-care: A cluster randomized controlled trial. Nutrition. 2016;32(2):199–205.

Table 1. Characteristics of the study population and the malnutrition groups

VARIABLES	Total BELFRAIL population n=567	MNA			Pre-albumin		
		No risk n=515 (90.8%)	At risk/malnourished n=52 (9.1%)	p-value	≥20 n=476 (87.3%)	<20 n=69 (12.7%)	p-value
Age (years), mean±SD	84.7±3.7	84.6±3.7	85.6±3.7	0.08[a]	84.6±3.6	85.9±4.1	0.01[a]
Sex, men (%)	211 (37.2)	199 (38.6)	12 (23.1)	0.03[c]	187 (39.3)	16 (23.2)	0.01[c]
BMI (kg/m²), mean ±SD	27.4 ±4.8	27.8±4.6	23.1±5.0	<0.01[a]	27.6±4.9	26.3±4.9	0.05[a]
Disease Count, mean±SD	4.1±2.2	4.1±2.2	4.6±2.0	0.08[a]	4.1±2.2	4.3±2.2	0.56[a]
ADL-score (6-30), median [IQR]	25 [21-27]	25 [21-27]	18 [12-24]	<0.01[b]	25 [21-27]	23 [20-27]	0.08[b]
MMSE (0-30), median [IQR]	28 [25-29]	28 [26-29]	24 [19-28]	<0.01[b]	28 [26-29]	27 [23-28]	<0.01[b]
GDS-15 (0-15), median [IQR]	2 [1-4]	2 [1-4]	4 [3-7]	<0.01[b]	2 [1-4]	2 [2-5]	0.64[b]
usCRP (mg/dL), median [IQR]	0.19 [0.08-0.41]	0.18 [0.08-0.40]	0.20 [0.08-0.57]	0.56[b]	0.17 [0.08-0.35]	0.48 [0.13-1.15]	<0.01[b]
Haemoglobin (g/dL), mean±SD	13.3 ±1.4	13.4±1.4	12.6±1.2	<0.01[a]	13.4±1.4	12.9±1.3	0.01[a]
Pre-albumin (mg/dL), median [IQR]	25.1 [21.9-29.0]	25.2 [22.0-29.1]	24.5 [20.5-28.2]	0.17[b]			
Deaths, No (%)	242 (42.7)	207 (40.2)	34 (65.4)	<0.01[c]	193 (40.5)	39 (56.5)	0.01[c]
Hospitalizations (%)	288 (50.8)	261 (51.1)	27 (55.1)	0.59[c]	236 (50.3)	39 (56.5)	0.34[c]
Instutionalized (%)	51 (10.1)	40 (7.8)	17 (32.7)	<0.01[c]	40 (10.1)	7 (10.1)	0.97[c]



MMSE = Mini-Mental State Examination; MNA = Mini Nutritional Assessment

Figure 1. Flowchart of data collection in the BELFRAIL cohort

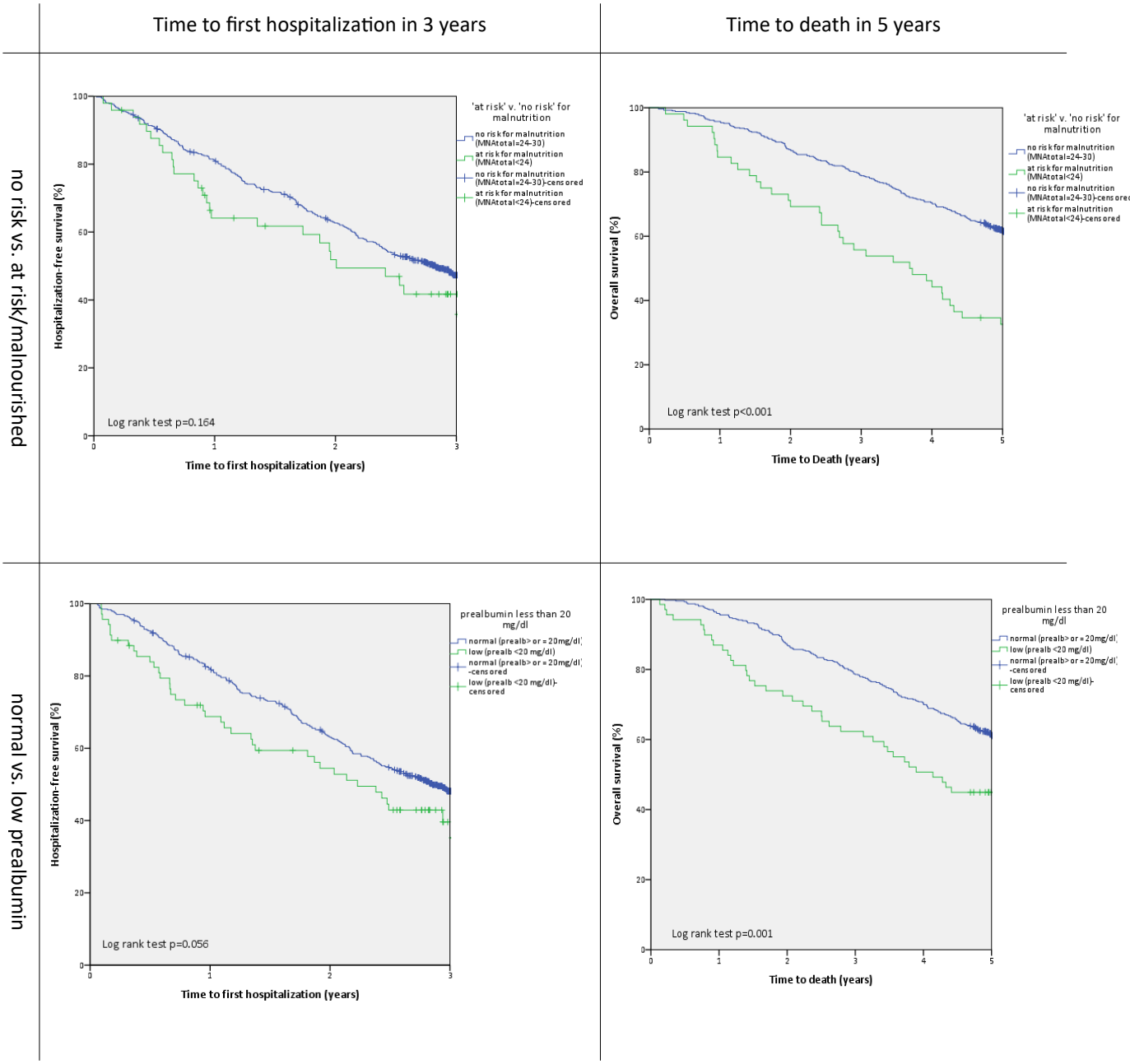


Figure 2. Kaplan Meier survival curves for mortality and hospitalization of malnutrition risk groups based on MNA and prealbumin

Table 2. Multivariate analysis of the association of the malnutrition risk based on MNA and prealbumin with hospitalization and mortality.

	HOSPITALIZATION HR (95% CI)					
Characteristics	Unadjusted model	P-value	Model a	P-value	Model b	P-value
Low MNA	1.32 (0.89-1.97)	0.17	0.83 (0.55-1.24)	0.36	1.08 (0.68-1.71)	0.76
Age			1.02 (0.99-1.05)	0.18	1.01 (0.98-1.05)	0.47
Sex (male)			1.36 (1.07-1.72)	0.01	1.31 (1.02-1.69)	0.04
DC			1.19 (1.13-1.25)	<0.00	1.20 (1.14-1.26)	<0.00
High CRP					1.40 (1.09-1.81)	0.01
Low MMSE					1.47 (1.08-2.01)	0.01
Low PPT					1.41 (1.08-1.84)	0.01
High GDS-15					1.02 (0.76-1.38)	0.88

	HOSPITALIZATION HR (95% CI)					
Characteristics	Unadjusted model	P-value	Model A	P-value	Model B	P-value
Low Prealbumin	1.39 (0.99-1.95)	0.06	1.55 (1.10-2.20)	0.01	1.30 (0.91-1.87)	0.15
Age			1.02 (0.99-1.07)	0.16	1.01 (0.98-1.04)	0.61
Sex (male)			1.38 (1.07-1.77)	0.01	1.35 (1.05-1.76)	0.02
DC			1.19 (1.13-1.26)	<0.01	1.20 (1.14-1.27)	<0.01
High CRP					1.36 (1.05-1.76)	0.02
Low MMSE					1.49 (1.11-2.01)	0.01
Low PPT					1.40 (1.07-1.84)	0.01
High GDS-15					1.02 (0.75-1.37)	0.92

	MORTALITY HR (95% CI)					
Characteristics	Unadjusted model	P-value	Model A	P-value	Model B	P-value
Low MNA	2.22 (1.55-3.18)	<0.01	1.87 (1.29-2.70)	<0.01	1.43 (0.93-2.19)	0.11
Age			1.10 (1.06-1.13)	<0.01	1.07 (1.04-1.11)	<0.01
Sex (male)			1.19 (0.91-1.55)	0.21	1.18 (0.89-1.58)	0.25
DC			1.12 (1.06-1.18)	<0.01	1.12 (1.06-1.19)	<0.01
High CRP					1.53 (1.16-2.02)	<0.01
Low MMSE					2.22 (1.63-3.02)	<0.01
Low PPT					1.52 (1.14-2.02)	0.01
High GDS-15					0.92 (0.66-1.27)	0.61

	MORTALITY HR (95% CI)					
Characteristics	Unadjusted model	P-value	Model A	P-value	Model B	P-value
Low Prealbumin	1.77 (1.25-2.50)	<0.01	1.72 (1.21-2.44)	<0.01	1.47 (1.01-2.13)	0.04
Age			1.10 (1.07-1.13)	<0.01	1.07 (1.03-1.11)	<0.01
Sex (male)			1.16 (0.89-1.53)	0.30	1.21 (0.91-1.62)	0.19
DC			1.14 (1.08-1.20)	<0.01	1.13 (1.07-1.20)	<0.01
High CRP					1.42 (1.07-1.88)	0.02
Low MMSE					2.29 (1.69-3.09)	<0.01
Low PPT					1.55 (1.16-2.08)	<0.01
High GDS-15					0.94 (0.68-1.30)	0.71

HR = Hazard Ratio; 95%CI = Confidence Interval;
MNA = Mini-Nutritional Assessement; malnutrition risk based on MNA (full MNA score <24);
DC = Disease Count; usCRP = ultrasensitive C-reactive protein; MMSE = Mini-Mental State Examination; GDS-15 = the 15-item Geriatric Depression Scale; PPT = Physical Performance Test
Model A = adjusted for age, sex, disease count
Model B = Model A + usCRP, MMSE, PPT, GDS-15

Table 3. Agreement between malnutrition groups based on MNA and prealbumin.

		Prealbumin (mg/dL)		
		normal (≥20)	low (<20)	Total
Malnutrition (MNA)	no risk (MNA≥24)	434	60	494
	at risk/ malnourished (MNA<24)	42	9	51
Total		476	69	545

Kappa K=0.047, p-value 0.261

Appendix: MNA questionnaire in Dutch

Mini Nutritional Assessment

MNA®

Nestlé Nutrition Institute

Achternaam: Voornaam:

Geslacht: Leeftijd: Gewicht, kg: Lengte, cm: Datum:

Vul het "Screening" gedeelte van het formulier in met de juiste antwoorden. Vervolgens de cijfers van de antwoorden optellen. Indien het totaal 11 of minder is, ga dan verder met de vragen onder de titel "Onderzoek", om een Ondervoedings Indicator score te bepalen.

Screening

A **Bent U de afgelopen 3 maanden minder gaan eten als gevolg van verminderde eetlust, spijsverterings-problemen, problemen bij het kauwen en/of slikken?**
0 = sterk verminderde eetlust
1 = matige verminderde eetlust
2 = geen verminderde eetlust ☐

B **Gewichtsverlies gedurende de afgelopen 3 maanden**
0 = gewichtsverlies groter dan 3 kg
1 = weet niet
2 = gewichtsverlies tussen 1 en 3 kg
3 = geen gewichtsverlies ☐

C **Mobiliteit**
0 = aan bed of stoel gebonden
1 = in staat zelfstandig uit bed/stoel te komen, maar gaat niet naar buiten
2 = gaat zelfstandig naar buiten ☐

D **Heeft U gedurende de afgelopen 3 maanden last gehad van psychische stress of een ernstige ziekte?**
0 = ja 2 = nee ☐

E **Neuropsychologische problemen**
0 = ernstig dement of depressief
1 = licht dement
2 = geen psychologische problemen ☐

F **Body Mass Index (BMI): (gewicht in kg) / (lengte in m)^2**
0 = BMI minder dan 19
1 = BMI tussen 19 en 21
2 = BMI tussen 21 en 23
3 = BMI 23 of meer. ☐

☐☐

Screening Score
(subtotaal max. 14 punten)

12-14 punten: ☐ normale voedingstoestand
8-11 punten: ☐ risico op ondervoeding
0-7 punten: ☐ ondervoed

Voor een meer uitgebreide analyse, ga door met vragen G t/m R

Onderzoek

G **Woont onafhankelijk (d.w.z. niet in een verpleeghuis of ziekenhuis)**
1 = ja 0 = nee ☐

H **Neemt dagelijks meer dan 3 voorgeschreven medicijnen**
0 = ja 1 = nee ☐

I **Decubitus of huidontstekingen**
0 = ja 1 = nee ☐

J **Aantal volledige maaltijden genuttigd per dag**
0 = 1 maaltijd
1 = 2 maaltijden
2 = 3 maaltijden ☐

K **Geselecteerde consumptie indicatoren voor eiwit inname**
- Tenminste één keer per dag consumptie van melkprodukten (melk, kaas, yoghurt) ja ☐ nee ☐
- Per week twee of meer porties peulvruchten of eieren ja ☐ nee ☐
- Dagelijks vlees, vis of gevogelte ja ☐ nee ☐

0.0 = indien 0 of 1 maal ja
0.5 = indien 2 maal ja
1.0 = indien 3 maal ja ☐.☐

L **Gebruikt 2 of meer porties fruit of groenten per dag**
0 = nee 1 = ja ☐

M **Hoeveel vocht (water, vruchtensap, koffie, thee, melk,...) wordt dagelijks genuttigd?**
0.0 = minder dan 3 glazen / koppen
0.5 = 3 tot 5 glazen / koppen
1.0 = meer dan 5 glazen / koppen ☐.☐

N **Manier van voeden**
0 = niet in staat zelfstandig te eten
1 = gebruikt de maaltijd met enige moeite
2 = gebruikt de maaltijd zelfstandig ☐

O **Oordeel van de patiënt zelf met betrekking tot zijn voedingskundige toestand**
0 = beoordeelt zichzelf als ondervoed
1 = is onzeker ten aanzien van de voedingskundige toestand
2 = beoordeelt zichzelf als zijnde zonder voedingskundige problemen ☐

P **Hoe beschouwt de patiënt zijn / haar gezondheidstoestand, in vergelijking met zijn / haar leeftijdsgenoten?**
0.0 = minder goed
0.5 = weet het niet
1.0 = even goed
2.0 = beter ☐.☐

Q **Middenarm omtrek (MAC) in cm**
0.0 = MAC minder dan 21
0.5 = MAC tussen 21 en 22
1.0 = MAC 22 of groter ☐.☐

R **Omtrek van de kuit (CC) in cm**
0 = CC kleiner dan 31
1 = CC 31 of groter ☐

Onderzoek score (max. 16 punten) ☐☐.☐
Screening score (max. 14 punten) ☐☐.☐
Ondervoedings Indicatie Score Totaal (max. 30 punten) ☐☐.☐

Ondervoedings Indicatie Score

24 tot 30 punten ☐ normale voedingstoestand
17 tot 23.5 punten ☐ risico op ondervoeding
Minder dan 17 punten ☐ ondervoed

Ref. Vellas B, Villars H, Abellan G, et al. *Overview of MNA® - Its History and Challenges.* J Nut Health Aging 2006; 10: 456-465.
Rubenstein LZ, Harker JO, Salva A, Guigoz Y, Vellas B. Screening for Undernutrition in Geriatric Practice: *Developing the Short-Form Mini Nutritional Assessment (MNA-SF).* J. Geront 2001; 56A: M366-377.
Guigoz Y. The Mini-Nutritional Assessment (MNA®) *Review of the Literature – What does it tell us?* J Nutr Health Aging 2006; 10: 466-487.
® Société des Produits Nestlé, S.A., Vevey, Switzerland, Trademark Owners
© Nestlé, 1994, Revision 2009. N67200 12/99 10M

Voor meer informatie: www.mna-elderly.com