

MINI NUTRITIONAL ASSESSMENT (MNA®)

Guigoz Y., Vellas B. & Garry P.J. (1994)

Mini Nutritional Assessment: a practical assessment tool for grading the nutritional state of elderly patients. *Nutrition, Facts and research in gerontology, supplement no.2.*

Meetinstrument	Mini Nutritional Assessment
Afkorting	MNA®
Auteur	Vellas B.J., Guigoz P.J. & Garry, P.J.
Thema	Ondervoeding
Doel	Opsporen van het risico op malnutritie
Populatie	Bejaarden
Afname	Zorgverlener
Aantal items	18
Aanwezigheid patiënt vereist	Ja
Vindplaats meetinstrument	Guigoz Y., Vellas B. & Garry P.J. (1994) Mini Nutritional Assessment: a practical assessment tool for grading the nutritional state of elderly patients. <i>Nutrition, Facts and research in gerontology, supplement no.2.</i> http://www.mna-elderly.com/mna_forms.html

DOEL

Het doel van de Mini Nutritional Assessemnt (MNA®) is de evaluatie van het risico op ondervoeding en de identificatie van personen die baat zouden hebben bij vroegtijdige interventie (Christensson, L., Unosson, M., & Ek, A. C., 2002; de Groot, L. C. P. G. & Beck, A. M., 1998; Vellas, B. et al., 1999; Guigoz, Y., Lauque, S., & Vellas, B. J., 2002).

DOELGROEP

De MNA® werd ontwikkeld voor bejaarden (Christensson, L., Unosson, M., & Ek, A. C., 2002; Vellas, B. et al., 1999) voor verschillende settings (Vellas, B. et al., 1999) zoals in de thuiszorg (voor bejaarden die zelfstandig wonen, voor de huisarts), de psychogeriatrische settings (bijvoorbeeld voor patiënten met Alzheimer), ziekenhuizen en andere instellingen (rust –en verzorgingstehuizen en faciliteiten voor verzorging op lange termijn) (Guigoz, Y., Lauque, S., & Vellas, B. J., 2002).

BESCHRIJVING

De MNA® bestaat uit 18 vragen onderverdeeld in 4 gebieden:

- *Antropometrische parameters*: gewicht, lengte, Body Mass Index (BMI), kuit –en bovenarmomtrek en gewichtsverlies
- *Algemene beoordeling* met betrekking tot levensstijl, medicatie, fysieke en mentale status
- *Voedselbeoordeling*: aantal maaltijden per dag, eetproblemen
- *Subjectieve beoordeling*; een vraag omtrent *zelfperceptie* en een vraag over de *gezondheidsstatus* (Christensson, L., Unosson, M., & Ek, A. C., 2002; Rubenstein, L. Z., Harker, J. O., Salva, A., Guigoz, Y., & Vellas, B., 2001; Vellas, B. et al., 1999; Guigoz, Y., Lauque, S., & Vellas, B. J., 2002; Guigoz, Y. & Vellas, B., 1999; Guigoz, Y., Vellas, B., & Garry, P. J., 1996).

De maximumscore is 30 punten. Een score lager dan 17 punten staat gelijk aan malnutritie. Een score tussen 17-23,5 geeft een risico aan op ondervoeding . Een score hoger of gelijk aan 24 geeft aan dat de persoon in een goede voedingstoestand verkeert (Christensson, L., Unosson, M., & Ek, A. C., 2002; de Groot, L. C. P. G. & Beck, A. M., 1998; Rubenstein, L. Z., Harker, J. O., Salva, A., Guigoz, Y., & Vellas, B., 2001; Guigoz, Y., Lauque, S., & Vellas, B. J., 2002; Guigoz, Y., Lauque, S., & Vellas, B. J., 2002).

VARIANTEN

1. Mini Nutritional Assessment -Short Form (MNA®-SF)

De MNA®-SF gebeurt in twee stappen. De eerste stap bestaat uit 6 items die voortkomen uit de volledige MNA (18 items) (Rubenstein, L. Z., Harker, J. O., Salva, A., Guigoz, Y., & Vellas, B., 2001; Guigoz, Y., Lauque, S., & Vellas, B. J., 2002; Baath, C., Hall-Lord, M., Idvall, E., Wiberg-Hedman, K., & Larsson, B. W., 2008). De maximumscore is 14. Scores van meer dan 12 geven een aanvaardbare voedingsstatus weer. Patiënten die geklassificeerd worden met “risico op ondervoeding” (score onder 11) dienen de volledige

MNA te vervolledigen, wat de tweede stap vormt (Rubenstein, L. Z., Harker, J. O., Salva, A., Guigoz, Y., & Vellas, B., 2001; Guigoz, Y., Lauque, S., & Vellas, B. J., 2002). Deze variant werd ook gevalideerd voor de pre-operatieve beoordeling van de voedingsstatus bij oudere chirurgische patiënten (Cohendy, R., Rubenstein, L. Z., & Eledjam, J. J., 2001).

2. modified-MNA (m-MNA)

Een andere variant van de MNA® is de m-MNA®. Deze blijkt geschikt voor ouderen met cognitieve dysfunctie en verschillende ziektebeelden. Deze variant bestaat uit 7 items (gewichtsverlies, mobiliteit, BMI, aantal volle maaltijden, drankverbruik, wijze van voeden, gezondheidsstatus). Er zijn nieuwe cut-off scores: 12,5 tot 15 betekent een goede voedingsstatus, een score tussen 9 en 12 toont een risico op ondervoeding en kleiner dan 9 geeft ondervoeding weer (Hengstermann, S., Nieczaj, R., Steinhagen-Thiessen, E., & Schulz, R. J., 2008c).

BETROUWBAARHEID

De *internal consistency* van de MNA® was hoog ($\alpha = 0.68 - 0.865$) (Bleda, M. J., Bolibar, I., Pares, R., & Salva, A., 2002; Rubenstein, L. Z., Harker, J. O., Salva, A., Guigoz, Y., & Vellas, B., 2001; Wikby, K. & Christensson, L., 2008). Dit gold eveneens voor de m-MNA® ($\alpha = 0.60$) (Hengstermann, S., Nieczaj, R., Steinhagen-Thiessen, E., & Schulz, R. J., 2008; Bleda, M. J., Bolibar, I., Pares, R., & Salva, A., 2002) en voor de MNA-SF ($\alpha = 0.843$) (Rubenstein, L. Z., Harker, J. O., Salva, A., Guigoz, Y., & Vellas, B., 2001a).

De waarden die uitdrukking gaven aan *equivalence* zijn uiteenlopend. Onder de vorm van *interrater reliability* werden zeer lage tot hoge kappa waarden gerapporteerd voor de MNA® ($\kappa = 0.04$ en 0.80) (Wikby, K. & Christensson, L., 2008). In een studie van Baath et al. (2008) werd een goede *interrater reliability* gerapporteerd voor de MNA-SF ($\kappa = 0.531-1.000$) ten opzichte van de totale MNA®-SF score. Tot slot werd ook de *stability* nagegaan van de MNA® met een hoge kappa waarde tot gevolg: 0.78. De intraclass correlation coëfficiënt (ICC) bedraagt 0.89 voor de totale MNA®-score (Bleda, M. J., Bolibar, I., Pares, R., & Salva, A., 2002).

VALIDITEIT

Het valideren van de MNA® gebeurde in eerste instantie bij 600 oudere personen (Guigoz, Y., Vellas, B., & Garry, P. J., 1996). *Concurrent validity* kon aangetoond worden. Een hoge *sensitiviteit*, een belangrijke

factor bij screeningsinstrumenten zoals deze voor ondervoeding, werd gevonden (72 en 100%). Uitzondering waren enkele onderzoeksresultaten met sensitiviteit intervallen tussen 27 en 57%. Het verleggen van de cut –off scores deed de specificiteit stijgen (Ferreira, L. S., Nascimento, L. F. C., & Marucci, M. F. N., 2008; Christensson, L., Unosson, M., & Ek, A. C., 2002; Murphy, M. C., Brooks, C. N., & Lumbers, M. L, 2000). De *specificiteit* lag tussen de 60 en 100%. Enkele studies gaven een specificiteit weer lager dan 47% (het verleggen van cut-off waarde en het bestuderen van andere populaties bleken hier aan de basis te liggen) (Murphy, M. C., Brooks, C. N., & Lumbers, M. L, 2000; Ferreira, L. S., Nascimento, L. F. C., & Marucci, M. F. N., 2008; Christensson, L., Unosson, M., & Ek, A. C., 2002; de Groot, L. C. P. G. & Beck, A. M., 1998). Studies beschreven goede correlaties tussen de MNA® en serum albumine enerzijds en de MNA® -SF anderzijds ($r= 0.699$ en 0.811) (Charlton, K. E., Kolbe-Alexander, T. L., & Nel, J. H. 2007; Rubenstein, L. Z., Harker, J. O., Salva, A., Guigoz, Y., & Vellas, B., 2001). Lage specificiteitratio's wezen erop dat veel patiënten onterecht als ondervoed worden geëindigd.

De waarden van de *positive predictive value* waren uiteenlopend, gaande van 16.3 % tot 77%. Ook voor de *negative predictive value* varieerden de waarden (47% tot 98%) (Charlton, K. E., Kolbe-Alexander, T. L., & Nel, J. H. 2007; Harris, D. G., Davies, C., Ward, H., & Haboubi, N. Y. 2008; Ferreira, L.S., Nascimento L.F.C. & Marucci, M.F.N, 2008). De mortaliteitsrate was significant hoger voor residenten die als ondervoed werden beschouwd (*predictive validity*) (Christensson, L., Unosson, M., & Ek, A. C., 2002; (Persson, M. D., Brismar, K. E., Katzarski, K. S., Nordenstrom, J., & Cederholm, T. E., 2002). *Discriminante validiteit* werd beschreven ten opzichte van de cognitieve functiescore ($r= -0.31$) (Charlton, K. E., Kolbe-Alexander, T. L., & Nel, J. H., 2007). Een principal component analysis werd uitgevoerd, waardoor de construct validity kon worden aangetoond (Guigoz, Y, Vellas, B., & Garry, P. J., 1994; Guigoz, Y., Vellas, B, & Garry, P. J., 1996).

Voor de MNA®- SF vielen de percentages van de sensitiviteit tussen 85.6 en 100%. De specificiteit lag tussen 69.5% en 100%. (Rubenstein, L. Z., Harker, J. O., Salva, A., Guigoz, Y., & Vellas, B., 2001; Murphy, M. C., Brooks, C. N., & Lumbers, M. L. 2000; Charlton, K. E., Kolbe-Alexander, T. L., & Nel, J. H. 2007; Wikby, K. & Christensson, L., 2008; Ranhoff, A. H., Gjoen, A. U., & Mowe, M. 2005; Cohendy, R., Rubenstein, L.Z, Eledjam, J.J. 2001). Een uitzondering (specificiteit van 38%) was de studie van Ranhoff et al. (2005). Er werden sterke correlaties gevonden van de MNA® –SF (tegenover de MNA® en de SGA), namelijk tussen 0.77 en 0.969 (Rubenstein, L. Z., Harker, J. O., Salva, A., Guigoz, Y., & Vellas, B., 2001; Charlton, K. E., Kolbe-Alexander, T. L., & Nel, J. H. 2007;(Persson, M. D., Brismar, K. E., Katzarski, K. S., Nordenstrom, J., & Cederholm, T. E., 2002). Ook lagere waarden ($r =0.22$ en 0.32) werden

gevonden (Charlton, K. E., Kolbe-Alexander, T. L., & Nel, J. H. 2007). Uit deze resultaten bleek de MNA®-SF een valide instrument te zijn. Om de m-MNA® te ontwikkelen werd de MNA® (18 items) gereduceerd tot 7 items met nieuwe cut-off scores door middel van een factoranalyse (Hengstermann, S., Nieczaj, R., Steinhagen-Thiessen, E., & Schulz, R. J., 2008b). De *concurrent validity* van de m-MNA® toonde goede resultaten ($r=0.910$; $P=0.001$) (Hengstermann, S., Nieczaj, R., Steinhagen-Thiessen, E., & Schulz, R. J., 2008d).

GEBRUIKSVRIENDELIJKHEID

Het vervolledigen van de MNA® nam 10 tot 15 minuten in beslag (Bauer, J. M., Kaiser, M. J., Anthony, P., Guigoz, Y., & Sieber, C. C., 2008; Rubenstein, L. Z., Harker, J. O., Salva, A., Guigoz, Y., & Vellas, B., 2001; Vellas, B. et al., 1999; Charlton, K. E., Kolbe-Alexander, T. L., & Nel, J. H., 2007). Murphy et al. (2000) gaven een invultijd aan van 30 minuten (vooral door het bekomen van de anthropometrische gegevens). De MNA®-SF en de m-MNA® nam slechts 3 minuten. De opleiding tot het gebruik van de MNA®-SF bleek kleiner dan de MNA® (Hengstermann, S., Nieczaj, R., Steinhagen-Thiessen, E., & Schulz, R. J., 2008; Rubenstein, L. Z., Harker, J. O., Salva, A., Guigoz, Y., & Vellas, B., 2001). Onderstaande tabel geeft de antwoorden weer van de experten over de gebruiksvriendelijkheid. Het cijfermateriaal komt overeen met het aantal experten die een welbepaald antwoord geformuleerd hebben. De individuele commentaren van de experten werden in bijlage toegevoegd (bijlage 3).

Helderheid	Helder	Min of meer	Niet helder	
Definitie	8	1	2	
Handleiding	8	1	2	
Eenvoud in gebruik	Ja		Nee	
Bijkomende opleiding nodig	4		6	
Niet telkens definities raadplegen	9		2	
Aanwezigheid patiënt vereist	10		1	
Actieve deelname patiënt	11		0	
Eenvoudige vragen	Ja	Min of meer	Nee	
	4	4	3	
			0	
Belemmering privacy	Ja		Nee	
	3		8	
Duur afname	< 1 min	1 - 3 min	>3 min-5min	> 5 min
Duur	0	1	5	5
Conclusie	Eenvoudig	Niet eenvoudig	Niet van toepassing	
Totaalsom berekenen eenvoudig	9	2	0	
Patiëntengroepen te onderscheiden	9	1	0	

TABEL 1: ANTWOORDEN VAN DE EXPERTEN OVER DE GEBRUIKSVRIENDELIJKHEID (N=11).

OPMERKINGEN

De MNA® bleek geen geschikt instrument voor patiënten die niet in staat waren een betrouwbare zelfbeoordeling te doen (verwarde patiënten, vergevorderde dementie, afasie and apraxie na een beroerte, of patiënten met ernstige of acute ziekten zoals longontstekingen). Een aangepaste versie van de MNA®, de m-MNA® kon voor deze patiënten soelaas bieden, daar deze gebruikt kon worden bij patiënten met cognitieve dysfunctie met verschillende ziektebeelden.

VINDPLAATS MEETINSTRUMENT

Guigoz, Y., Vellas, B., & Garry, P. J. (1994). Mini Nutritional Assessment: a practical assessment tool for grading the nutritional state of elderly patients. *Nutrition, Facts and research in gerontology, supplement no.2.* http://www.mna-elderly.com/mna_forms.html

REFERENTIES

- Baath, C., Hall-Lord, M., Idvall, E., Wiberg-Hedman, K., & Larsson, B. W. (2008). Interrater Reliability Using Modified Norton Scale, Pressure Ulcer Card, Short Form-Mini Nutritional Assessment By Registered And Enrolled Nurses In Clinical Practice. *Journal Of Clinical Nursing*, 17, 618-626.
- Bauer, J. M., Vogl, T., Wicklein, S., Trogner, J., Muhlberg, W., & Sieber, C. C. (2005). Comparison Of The Mini Nutritional Assessment, Subjective Global Assessment, And Nutritional Risk Screening (Nrs 2002) For Nutritional Screening And Assessment In Geriatric Hospital Patients. *Z.Gerontol.Geriatr.*, 38, 322-327.
- Bleda, M. J., Bolibar, I., Pares, R., & Salva, A. (2002). Reliability of the mini nutritional assessment (MNA) in institutionalized elderly people. *J.Nutr.Health Aging*, 6, 134-137.
- Charlton, K. E., Kolbe-Alexander, T. L., & Nel, J. H. (2007). The Mna, But Not The Determine, Screening Tool Is A Valid Indicator Of Nutritional Status In Elderly Africans. *Nutrition*, 23, 533-542.
- Christensson, L., Unoosson, M., & Ek, A. C. (2002). Evaluation Of Nutritional Assessment Techniques In Elderly People Newly Admitted To Municipal Care. *Eur.J.Clin.Nutr.*, 56, 810-818.
- Cohendy, R., Rubenstein, L. Z., & Eledjam, J. J. (2001). The Mini Nutritional Assessment-short form for pre-operative nutritional evaluation of elderly patients. *Aging*, 13, 293-297.
- De Groot, L. C. P. G. & Beck, A. M. (1998). Evaluating The Determine Your Nutrutional Health Checklist And The Mini Nutritional Assessment.. *European Journal Of Clinical Nutrition*, 52, 877.
- Ferreira, L. S., Nascimento, L. F. C., & Marucci, M. F. N. (2008). Use of the mini nutritional assessment tool in elderly people from long-term care institutions of southeast of Brazil. *The Journal of Nutrition, Health and Aging*, 12, 213-217.
- Guigoz, Y., Vellas, B., & Garry, P. J. (1994). Mini Nutritional Assessment: a practical assessment tool for grading the nutritional state of elderly patients. *Nutrition, Facts and research in gerontology, supplement no.2*.
- Harris, D. G., Davies, C., Ward, H., & Haboubi, N. Y. (2008). An Observational Study Of Screening For Malnutrition In Elderly People Living In Sheltered Accommodation. *J.Hum.Nutr.Diet.*, 21, 3-9.

Hengstermann, S., Nieczaj, R., Steinhagen-Thiessen, E., & Schulz, R. J. (2008). Which are the most efficient items of mini nutritional assessment in multimorbid patients? *J.Nutr.Health Aging*, 12, 117-122.

Murphy, M. C., Brooks, C. N., & Lumbers, M. L. (2000). The Use Of The Mini-Nutritional Assessment (MNA) Tool In Elderly Orthopaedic Patients. *Eur J Clin Nutr.*, 54, 555-562.

Persson, M. D., Brismar, K. E., Katzarski, K. S., Nordenstrom, J., & Cederholm, T. E. (2002). Nutritional Status Using Mini Nutritional Assessment And Subjective Global Assessment Predict Mortality In Geriatric Patients. *J.Am.Geriatr.Soc.*, 50, 1996-2002.

Ranhoff, A. H., Gjoen, A. U., & Mowe, M. (2005). Screening for malnutrition in elderly acute medical patients: the usefulness of MNA-SF. *J.Nutr.Health Aging*, 9, 221-225.

Rubenstein, L. Z., Harker, J., & Guigoz, Y. V. B. (1999). Comprehensive geriatric assessment (CGA) and the MNA: an overview of CGA, nutritional assessment, and development of a shortened version of the MNA. *Mini Nutritional Assessment (MNA): Research and Practice in the Elderly*, ed B Vellas, PJ Garry & Y Guigoz, Nestlé Workshop Series Clinical & Performance Programme. Basel Nestlé, 1, 101-116.

Rubenstein, L. Z., Harker, J. O., Salva, A., Guigoz, Y., & Vellas, B. (2001). Screening For Undernutrition In Geriatric Practice: Developing The Short-Form Mini-Nutritional Assessment (Mna-Sf). *J.Gerontol.A Biol.Sci.Med.Sci.*, 56, M366-M372.

Vellas, B., Guigoz, Y., Baumgartner, M., Garry, P. J., Lauque, S., & Albareda, J. L. (2000). Relationships Between Nutritional Markers And The Mini-Nutritional Assessment In 155 Older Persons. *J.Am.Geriatr.Soc.*, 48, 1300-1309.

Wikby, K. & Christensson, L. (2008). The Two-Step Mini Nutritional Assessment Procedure In Community Resident Homes. *Journal Of Clinical Nursing*, 17, 1211-1218.

The Mini Nutritional Assessment (MNA®)

Guigoz Y., Vellas B. & Garry P.J. (1994)

Author (year)	Setting	Sample (n)	Design	Reliability	Validity
(Christensson, L., Unosson, M., & Ek, A. C., 2002)	A municipality (South of Sweden)	n= 261 148 female, 113 male newly admitted to special types of housing for the elderly	Cross-sectional study.		CrV Sen/ Sp OR
(de Groot, L. C. P. G. & Beck, A. M., 1998)	Several European countries	(n=1161) Community dwelling elderly	Retrospective study		CrV Sen/ Sp
(Wikby, K. & Christensson, L., 2008)	Residential homes in a municipality in Southern Sweden.	Older people (n= 127)	Not specified	IC E	
(Rubenstein, L. Z., Harker, J. O., Salva, A., Guigoz, Y., & Vellas, B., 2001b) (Rubenstein, L. Z., Harker, J., & Guigoz, Y. Vellas B., 1999)	France (database used of Toulouse-91), Spain and New Mexico	France (n=151): Hospitalized geriatric patients (n= 105) & healthy community dwelling elderly (n= 50) Spain (n=400): Elderly persons in a subacute convalescent unit (n=114), elderly persons in a large board-and-care facility (n=89) & independently community dwelling elderly persons(n=199) New Mexico (n=347): Elderly from the New Mexico Aging Process study	Validation Study Development of a screening version of the MNA®, the SF-MNA®	IC	Sen Sp

Betrouwbaarheid/ fiabilité: Stability (S), Internal Consistency (IC), Equivalence (E)

Validiteit/ validité: Face Validity (FV), Content Validity (CtV), Criterion Validity (CrV), Construct Validity (CsV)

Sensitivity (Sen), Specificity (Sp), Positive Predictive Value (PPV), Negative Predictive Value (NPV), Receiver Operating Curve (ROC), Likelihood Ratio (LR), Odds Ratio (OR), Area Under the Curve (AUC)

Results reliability	Results validity	Commentary
	<p>CrV concurrent validity</p> <p>WI (Weight Index) was the objective nutritional parameter which best predicted the dichotomized classification OR 0,95 ($P<0,000$, CI 0,94-0,98)</p> <p>Second best predictor: serum albumin OR 0,90 ($P<0,003$, CI 0,84-0,97)</p> <p>CrV concurrent validity</p> <p>The researchers separated the MNA® in well nourished (= MNA 1) and malnourished (MNA 2+3) to test it against PEM-non PEM (Protein-Energy Malnutrition). Sensitivity in detecting PEM was 0.96, specificity in detecting PEM: 0.26</p> <p>The optimal cut-off point in MNA® in order to detect PEM was established at MNA® score <20. Using this cut-off point: Sen 0,76 Sp 0,70</p> <p>CrV Predictive validity</p> <p>Mortality rate 6 months after admission was significantly higher in residents classified as malnourished as compared to well-nourished.</p>	
	<p>CrV</p> <p>Body Weight Loss ($\geq 10\%$) as criterion variable:</p> <p>Sen 0.96 Sp 0.60</p>	Serum albumin values (<30g/l), lymphocyte counts (<1500/ml), Body Mass Index (<20kg/ m ²) and weight loss ($\geq 10\%$) were used as standards to calculate specificity and sensitivity. Using serum albumin values and lymphocyte counts as standards, specificity & sensitivity were < 0.60.

Betrouwbaarheid/ fiabilité: Stability (S), Internal Consistency (IC), Equivalence (E)

Validiteit/ validité: Face Validity (FV), Content Validity (CtV), Criterion Validity (CrV), Construct Validity (CsV)

Sensitivity (Sen), Specificity (Sp), Positive Predictive Value (PPV), Negative Predictive Value (NPV), Receiver Operating Curve (ROC), Likelihood Ratio (LR), Odds Ratio (OR), Area Under the Curve (AUC)

Results reliability	Results validity	Commentary
IC $\alpha=0.68$ E Interrater reliability The agreement between the author's and registered nurses' assessments was 62% ($\kappa= 0.41$) for the MNA®. In residential home A, B and C the agreement was 89% ($\kappa= 0.77$), 89% ($\kappa= 0.80$) and 44% ($\kappa= 0.04$).	CrV The sensitivity of the MNA®-SF versus the full MNA® was high (89%). Specificity was 82%.	
IC Good internal consistency for the 6-item scale ($\alpha=0.843$) compared with $\alpha=0.865$ for the full-MNA® (reducing to 5 or 4 items, IC reduced)	CrV: Concurrent validity (France Sample, used to derive MNA®-SF). 1. To derive the MNA®-SF "physician judgement of clinical nutritional status" as gold standard. Sen 0.978 Sp 0.943 2. Correlation between MNA®-SF and full MNA® ($r=0.969$) 3. In use of a cut-off score of ≥ 11 (normal nutrition), sensitivity and specificity were calculated from MNA®-SF. Sen 97.9% Sp 100% 4. Pearson correlation between serum albumin and MNA®-SF was 0.679 (is similar to that between albumin and the full MNA®: $r= 0.699$) CrV Concurrent validity (Spain and New Mexico sample) Full MNA®, as gold standard, they found a high correlation ($r=0.945$). There is a relationship of full MNA® and MNA®-SF with albumin.	Six items of the full MNA® with highest sensitivity and specificity were selected for the MNA®-SF The optimal threshold score for normal nutrition in the MNA®-SF appeared to be ≥ 11 . However, increasing sensitivity by raising the threshold for "normal" to ≥ 12 should be considered (= more sensitive threshold).

Betrouwbaarheid/ fiabilité: Stability (S), Internal Consistency (IC), Equivalence (E)

Validiteit/ validité: Face Validity (FV), Content Validity (CtV), Criterion Validity (CrV), Construct Validity (CsV)

Sensitivity (Sen), Specificity (Sp), Positive Predictive Value (PPV), Negative Predictive Value (NPV), Receiver Operating Curve (ROC), Likelihood Ratio (LR), Odds Ratio (OR), Area Under the Curve (AUC)

Author (year)	Setting	Sample (n)	Design	Reliability	Validity
(Baath, C., Hall-Lord, M., Idvall, E., Wiberg-Hedman, K., & Larsson, B. W., 2008)	Orthopaedic and stroke wards 3 hospitals in two county councils Sweden	Registered nurses (n= 50); 49 female, 1 male Enrolled nurses (n=61); 58 female, 3 men	Cross sectional	E	
(Murphy, M. C., Brooks, C. N., & Lumbers, M. L., 2000)	Royal Surrey County Hospital (RSCH), Guildford. United Kingdom	Orthopaedic patients (n= 49) all female (mean age 79.5y)	Observation study		Sen Sp
(Cohendy, R., Rubenstein, L. Z., & Eledjam, J. J., 2001)	Centre Hospitalier Universitaire de Nîmes, France ; Clinique Beausoleil, Montpellier, France	Ambulatory patients scheduled for elective surgery or exploration under anesthesia (n=408)	Not specified		Sen/ Spec PPV/ NPV LR+/ LR-

Betrouwbaarheid/ fiabilité: Stability (S), Internal Consistency (IC), Equivalence (E)

Validiteit/ validité: Face Validity (FV), Content Validity (CtV), Criterion Validity (CrV), Construct Validity (CsV)

Sensitivity (Sen), Specificity (Sp), Positive Predictive Value (PPV), Negative Predictive Value (NPV), Receiver Operating Curve (ROC), Likelihood Ratio (LR), Odds Ratio (OR), Area Under the Curve (AUC)

Results reliability	Results validity	Commentary
<p>E Interrater reliability (95% CI)</p> <p><u>Between RNs and ENs</u> Very good agreement for MNA®-SF ($\kappa=1.000$).</p> <p><u>Among RNs</u> Good agreement for MNA®-SF ($\kappa= 0.673$).</p> <p><u>Among ENs</u> Moderate agreement for the MNA®-SF score ($\kappa=0.531$).</p>		The interrater reliability was measured using (κ) for nominal and (κ_w) for ordinal variables.
	<p>CrV <u>Using a score < 17 (= malnourished)</u></p> <p>Albumin level as comparison (cut-off: 35g/l) Sen 27% Sp 66%</p> <p>Energy intake (cut-off: <2997kJ/day) Sen 57% Sp 94%</p> <p>Mindex (cut-off 81.7kg/m) Sen 33% Sp 100%</p> <p><u>Using a score < 23.5 (=malnourished+at risk)</u></p> <p>Albumin level as comparison (cut-off: 35g/l) Sen 75% Sp 50%</p> <p>Energy intake (cut-off: <2997kJ/day) Sen 100% Sp 37% . A higher cut-off (4054kJ/day): Sen 72%, Sp 32%</p> <p>Mindex (cut-off 81.7kg/m) Sen 81% Sp 47%</p>	The small number of subjects in each category suggested that caution should been used when interpreting the results.
	<p>MNA- SF (<17)Sen 100% Sp 69.5% PPV 19.4% NPV 100% LR- 0 LR+3.28</p> <p>MNA-SF(<23.5)Sen 85.6% Sp 88.8% PPV 78.5% NPV 92.8% LR+7.64 LR- 0.16 OR 47.75</p>	

Betrouwbaarheid/ fiabilité: Stability (S), Internal Consistency (IC), Equivalence (E)

Validiteit/ validité: Face Validity (FV), Content Validity (CtV), Criterion Validity (CrV), Construct Validity (CsV)

Sensitivity (Sen), Specificity (Sp), Positive Predictive Value (PPV), Negative Predictive Value (NPV), Receiver Operating Curve (ROC), Likelihood Ratio (LR), Odds Ratio (OR), Area Under the Curve (AUC)

Author (year)	Setting	Sample (n)	Design	Reliability	Validity
(Harris, D. G., Davies, C., Ward, H., & Haboubi, N. Y., 2008c)	Elderly living in controlled sheltered accomodation	69 female 31 male (n= 100)	Observational study		Sen Sp PPV NPV LR
(Bauer, J. M. et al., 2005)	2 acute geriatric wards	112 geriatric hospital patients	Comparative prospective study		CrV
(Ferreira, L. S., Nascimento, L. F. C., & Marucci, M. F. N., 2008)	Long -term institutions in the Southeast of Brazil	Elderly (n=89)	Transversal study		CrV Sen/ Sp PPV/ NPV
(Vellas, B. et al., 2000)	Geriatric evaluation unit (hospital) and the community in Toulouse, France	Older subjects (n= 155), 53 male, 102 female/ Geriatric unit (n=105) Community (n=50)	Prospective study		CrV
(Persson, M. D., Brismar, K. E., Katzarski, K. S., Nordenstrom, J., & Cederholm, T. E., 2002)	Acute geriatric inpatient wards	Acute geriatric patients (n= 83)	Prospective follow-up study		CrV
(Ranhoff, A. H., Gjoen, A. U., & Mowe, M., 2005)	General internal medical department, Ullevaal Hospital	Elderly acute medical patients (n=69)	Observational study		CrV

Betrouwbaarheid/ fiabilité: Stability (S), Internal Consistency (IC), Equivalence (E)

Validiteit/ validité: Face Validity (FV), Content Validity (CtV), Criterion Validity (CrV), Construct Validity (CsV)

Sensitivity (Sen), Specificity (Sp), Positive Predictive Value (PPV), Negative Predictive Value (NPV), Receiver Operating Curve (ROC), Likelihood Ratio (LR), Odds Ratio (OR), Area Under the Curve (AUC)

Results reliability	Results validity	Commentary
	<p>CrV</p> <p>A dietician & doctor assessment was used as gold standard. Using a cut -off score of < 12 as malnourished, accuracy for MNA®:</p> <p>Sen 80% Sp 90%</p> <p>PPV 0.47 NPV 0.98</p> <p>LR + 8 LR - 0.22</p>	The study had a small sample size.
	<p>CrV Concurrent validity</p> <p>Researchers found highly significant associations between the nutritional condition of patients according to the different tests (SGA, NRS 2002 & MNA®) and BMI (Kruskal-Wallis, p<0.01)</p> <p>Relationship was tested between results of 3 different assessment tools and the serum albumin level. A significant relationship was found only for MNA (Kruskal-Wallis, p<0.05).</p> <p>Predictive validity A significant association was found for length of stay (P=0.044)</p>	The researchers found, like other authors, that the MNA® was not a suitable instrument for patients who cannot provide a reliable self -assessment (patients with confusion, advanced dementia, serious post stroke aphasia and apraxia, or patient with severe acute diseases like pneumonia).
	<p>CrV Concurrent validity</p> <p>The corrected arm muscle area (considered as a good indicator for malnutrition) was used as a 'standard' for the nutritional diagnosis of elderly people.</p> <p>Sen 84% Sp 36% PPV 77% NPV 47% AUC 71%</p>	<p>The study had a small sample size.</p> <p>The MNA® cut -off points were set for Brazilian elderly people and not for Europeans.</p>

Betrouwbaarheid/ fiabilité: Stability (S), Internal Consistency (IC), Equivalence (E)

Validiteit/ validité: Face Validity (FV), Content Validity (CtV), Criterion Validity (CrV), Construct Validity (CsV)

Sensitivity (Sen), Specificity (Sp), Positive Predictive Value (PPV), Negative Predictive Value (NPV), Receiver Operating Curve (ROC), Likelihood Ratio (LR), Odds Ratio (OR), Area Under the Curve (AUC)

Results reliability	Results validity	Commentary
	<p>CrV Concurrent validity Significant correlation between MNA® classified at risk for malnutrition (score between 17 and 23,5) and:</p> <ul style="list-style-type: none"> - Anthropometry ($P=0.001$) - Biochemical measurements ($P=0.001$) albumin, transthyretin, transferrin, cholesterol, retinol, alpha-tocopherol, 25-OH cholecalciferol zinc - Nutritional intake ($P <0.05$): energy, carbohydrates, fiber, calcium, vitamin D, iron, vitamin B6, vitamin C 	BMI and serum albumin measurements only have several limitations. Older patients with a high BMI can have undernutrition. Their nutritional intake is low due to disease or functional impairments. In the same way, serum albumin measurement is limited in those persons with dehydratation, inflammatory disease or an underlying condition.
	<p>CrV Concurrent validity High correlation of MNA® against MNA®-SF and SGA ($r= 0.77$ to 0.93)</p> <p>MNA® correlated with following objective nutritional indicators: Anthropometry (weight, height, BMI, arm anthropometry) and body composition analysis. No correlation was found between MNA® and biochemical measurements (serum albumin and serum IGF-I)</p> <p>CrV Predictive validity Mortality was higher in malnourished patients (40% after 1 yr, 80% after 3 yrs) compared with patients classified as well nourished (20% after 1 yr ($P=0.03-0.17$), 50% after 3 yrs ($p<0.01$))</p>	Nearly the half of the patients suffered from infections. This might have had an effect on the results.
	<p>CrV Concurrent validity MNA®-SF scoring was compared to comprehensive assessment by a clinical nutritionist (gold standard). The nutritionist's assessment was based on clinical status and a comprehensive nutritional assessment including anthropometrical markers and history of dietary intake.</p> <p>Sen 100% Sp 38% Sensitivity was 86% and specificity 71% when using BMI <23</p>	

Betrouwbaarheid/ fiabilité: Stability (S), Internal Consistency (IC), Equivalence (E)

Validiteit/ validité: Face Validity (FV), Content Validity (CtV), Criterion Validity (CrV), Construct Validity (CsV)

Sensitivity (Sen), Specificity (Sp), Positive Predictive Value (PPV), Negative Predictive Value (NPV), Receiver Operating Curve (ROC), Likelihood Ratio (LR), Odds Ratio (OR), Area Under the Curve (AUC)

Author (year)	Setting	Sample (n)	Design	Reliability	Validity
(Hengstermann, S., Nieczaj, R., Steinhagen-Thiessen, E., & Schulz, R. J., 2008a)	An acute geriatric hospital: Evangelisches Geriatrisches Zentrum Berlin (Germany)	Multimorbid elderly patients (n=808)	Cross-sectional study	IC	CsV
(Bleda, M. J., Bolibar, I., Pares, R., & Salva, A., 2002)	2 long term geriatric units in Mataro (Spain)	(n=67)	Interobserver reliability study	S IC E	
(Charlton, K. E., Kolbe-Alexander, T. L., & Nel, J. H., 2007)	Peri-urban areas of Cape Town, South Africa.	Free living in the community or institutionalized black South Africans (n= 283); 230 female, 53 men	Cross sectional validation study		Sen/ Sp PPV/ NPV
(Guigoz, Y., Vellas, B., & Garry, P. J., 1996) (Guigoz, Y., Vellas, B., & Garry, P. J., 1994)	Clinical center and the Third Age University, Toulouse (study 1 & 2)	<u>Developmental study (1)</u> <u>Elderly subjects (n=155)</u> <u>Validation study (2)</u> <u>Elderly (n=120)</u> <u>Screening study (3)</u> Non institutionalized elderly (New Mexico Aging Process study)	Validation en development study		CrV CsV

Betrouwbaarheid/ fiabilité: Stability (S), Internal Consistency (IC), Equivalence (E)

Validiteit/ validité: Face Validity (FV), Content Validity (CtV), Criterion Validity (CrV), Construct Validity (CsV)

Sensitivity (Sen), Specificity (Sp), Positive Predictive Value (PPV), Negative Predictive Value (NPV), Receiver Operating Curve (ROC), Likelihood Ratio (LR), Odds Ratio (OR), Area Under the Curve (AUC)

Results reliability	Results validity	Commentary
IC For the m-MNA® Chronbach's alpha= 0.60	CsV Factor analysis (principal component analysis) was carried out: MNA®-items were reduced from 18 to 7 items with new cut-offs (12,5-15= well-nourished; 9-12 at risk of malnutrition;<9 malnourished). CrV Concurrent validity The MNA® and modified MNA® (m-MNA®) score correlated with $r=0.910$ ($P=0.001$). The area under the ROC-curve (AUC) is 0.968	
S Intraclass correlation coefficient (ICC) for the total MNA® score for the two administrations was 0.89. At one hospital it was 0.78 (25 patients), at the other is was 0.93 (42 patients). The stratification of the total MNA® score in 3 categories of nutritional status obtained $\kappa= 0.78$. 12 items had 'almost perfect or substantial Kappa indices (κ) (66.7%); 5 items moderate or fair indices (κ) (27.8%); 1 item had a slight or poor Kappa index (κ). IC 1 st assessment: Total MNA® $\alpha = 0.83$ (one side 95 % CI of 0.78) 2 nd assessment: Total MNA® $\alpha = 0.74$ (one side 95 % CI of 0.66)		

Betrouwbaarheid/ fiabilité: Stability (S), Internal Consistency (IC), Equivalence (E)

Validiteit/ validité: Face Validity (FV), Content Validity (CtV), Criterion Validity (CrV), Construct Validity (CsV)

Sensitivity (Sen), Specificity (Sp), Positive Predictive Value (PPV), Negative Predictive Value (NPV), Receiver Operating Curve (ROC), Likelihood Ratio (LR), Odds Ratio (OR), Area Under the Curve (AUC)

Results reliability	Results validity	Commentary
	<p>CrV Concurrent Validity</p> <p>MNA®-SF vs MNA® (cut-off score ≥ 11 = normal) Sen 100% Sp 94.6% PPV 16.3% NPV 62.9%</p> <p>MNA®-MNA®-SF: r= 0.811, P<0.0001, n= 220</p> <p>BMI - MNA®-SF r= 0.32, P<0.0001, Mid Arm Circumference (MAC) – MNA®-SF r=0.28, Calf Circumference (CC) – MNA®-SF r= 0.27, Red blood cell folate – MNA®-SF r= 0.22, P=0.0026, Cognitive function score- MNA®-SF r=-0.31, P<0.0001</p>	
	<p>CrV Concurrent validity</p> <p>Study 1</p> <ul style="list-style-type: none"> - MNA test was validated against 2 criteria: clinical status (by 2 physicians) and a comprehensive nutrition assessment using principal component analysis & discriminant analysis. The results suggested that the MNA® could correctly assess the nutritional status without the use of biochemical measurements. <p>Study 2</p> <p>MNA® was compared to clinical status by discriminant analysis (MNA® correctly classified 89% of the subjects)</p> <p>Classification potential of the MNA was done by cross-classification of subjects (1991 and 1993 study) using discriminant analysis; clinical status was used as reference standard (cross-validation)</p>	

Betrouwbaarheid/ fiabilité: Stability (S), Internal Consistency (IC), Equivalence (E)

Validiteit/ validité: Face Validity (FV), Content Validity (CtV), Criterion Validity (CrV), Construct Validity (CsV)

Sensitivity (Sen), Specificity (Sp), Positive Predictive Value (PPV), Negative Predictive Value (NPV), Receiver Operating Curve (ROC), Likelihood Ratio (LR), Odds Ratio (OR), Area Under the Curve