The Mini Nutritional Assessment (MNA) after 20 years of research and clinical practice

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Introduction

Nutritional assessment in older people to detect malnutrition or risk of malnutrition is essential to avoid adverse nutrition-related outcomes. Poor nutritional status appears to be a major contributing factor for poor prognosis in malnourished individuals. Nowadays, nutritional assessment is considered to be one of the domains which should be evaluated in comprehensive geriatric assessment (CGA). CGA is a comprehensive assessment tool with the capacity of detecting impairments in older people and, at the same time, suggest interventions. Although many assessment tools are proposed, those used in CGA are not widely agreed. After 20 years of clinical practice and research, the Mini Nutritional Assessment (MNA) seems to be the tool most widely accepted by health carers and patients for the assessment of nutritional impairment in CGA.

MNA classifies, with well-established thresholds, the nutritional status of older people with the added advantage of proposing and guiding interventions. Even more, the MNA is correlated to nutritional interventions when these are successful, with improved scores showing response to the intervention.

Several studies have shown that older people at risk of or suffering malnutrition have a worse prognosis in terms of different adverse clinical outcomes. In community-dwelling elderly people, malnutrition is associated with diminished cognitive and functional performance, diminished self-care ability,1,2 worse oral health, poor eyesight and several difficulties with mealtimes such as problems in using a fork or a knife.3 In hospitalized patients, depression scores (using the Geriatric Depression Score) were higher in malnourished patients than in those who were at risk.4 Many studies have shown that low MNA scores are predictive of adverse outcomes, including longer lengths of hospital stay, more frequent discharges to a nursing home and a nearly threefold increase in mortality.4–8 Weight loss and malnutrition are major complications of Alzheimer’s disease (AD).9 After a one-year follow-up of community-dwelling elderly patients suffering from Alzheimer’s disease, lower nutritional status, measured by the MNA, was found to be associated with risk of institutionalization, and lower MNA scores were found in emergency hospital admissions.10,11

The aim of the present paper was to perform an exhaustive review on the MNA by revising the relevant literature on the topic after more than 20 years of research and clinical practice.

Historical background

The development of the MNA began during the 1989 International Association of Geriatrics and Gerontology (IAGG) meeting in Acapulco with a discussion between Bruno Vellas (Department of Geriatric Medicine, Toulouse University Hospital, France) and Yves Guigoz (Researcher at the Nestlé Research Centre, Switzerland). This meeting highlighted that even if there was proven evidence of the high prevalence of malnutrition in institutionalized, frail and hospitalized older people, nutritional assessment was not currently performed in clinical practice due to the complexity of nutritional evaluation. The aim of the discussion was to design an assessment tool for nutritional status in older people, analogous to the Mini-Mental State Examination (MMSE) for the assessment of cognitive function,12 reliable, cheap and quick to perform.

The MNA was initially validated in a cohort of more than 150 healthy, frail and acutely ill elderly

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patients in Toulouse, France, between 1990 and 1991. Subsequently, the MNA was validated in the New-Mexico Aging Process Study (NMAPS), a longitudinal survey on nutrition and aging and in 2001 by the Nestlé Research Centre in Lausanne (Switzerland). Thus the MNA was validated, in three studies assessing more than 600 older persons, using two principal validation criteria: (1) Clinical status, which consisted of a nutritional assessment conducted independently by two physicians trained in nutrition, on the basis of the subject’s clinical record without the knowledge of the MNA result; and (2) a comprehensive nutritional assessment which included a complete assessment of anthropometrics, biochemical markers such as vitamins, trace minerals and proteins status, and a complete three-day dietary intake record.

The first article, that included the MNA for the assessment of nutritional status, was published in 1994. In 2001, a short form of the MNA (MNA-SF) was developed in collaboration with L.Z Rubenstein. The MNA-SF is a validated shortened version of the MNA, allowing a two-step screening process in low-risk populations that retains the validity and accuracy of the full MNA. Since 1994, the MNA has been translated into almost 20 languages and has been used for nutritional evaluation in nearly 200 scientific publications in PubMed/Medline. Many articles have evaluated the sensitivity, specificity and reliability of the MNA in different settings and countries. In both medical practice and clinical research, the MNA is by far the most widely used tool for nutritional screening and assessment in older people.

The MNA: description of the tool

The MNA is able to classify older people as well nourished, at risk for malnutrition or malnourished. The MNA consists of 18 self-reported questions derived from four parameters of assessment: anthropometric assessment, general assessment, dietary assessment and self-assessment (see Figure 1) administered in two steps. The MNA-SF is a screening tool composed of the first six items (of the 18 questions) that permits detection of a decline in ingression over the past three months (loss of appetite, decline of food intake, digestive problems, chewing or swallowing difficulties), weight loss in the past three months, current mobility impairment, an acute illness or major stress in the past three months, a neuropsychological problem (dementia or depression) and a decrease in body mass index (BMI). If indicated after Step 1 (MNA-SF), the risk of malnutrition should be assessed using the full MNA. The MNA evaluates living arrangements, the presence of polypharmacy or pressure ulcers, the number of full meals eaten daily, the amount and frequency of specific foods and fluids, and the mode of feeding. The patient reports nutritional and health status, and the practitioner determines weight and height (to calculate BMI), and mid-arm and mid-calf circumferences.

As stated earlier, nutritional status using the MNA should be evaluated using a two-step process. The first step, the MNA-SF, takes only few minutes to complete. The maximum score for this part is 14; a score of 12 points or greater indicate that the patient has an acceptable nutritional status and that it is not necessary to complete the full MNA. However, a score of 11 points or below is an indication to proceed with the complete version of the MNA. The full MNA can be performed in 10 to 15 minutes. The maximum score for the second part is 16. Scores from the two parts must be added to obtain the malnutrition indicator score. Each answer in the two parts has a numerical value and contributes to the final score, which has a maximum of 30. Assessment of the cognitive status of the patient should be obtained by the caregiver, or by the medical or nursing staff. If a cognitive decline is present, answers should be checked by proxies (caregiver, or medical or nursing staff). If the patient suffers from severe cognitive decline, the caregiver or nursing staff can complete the MNA instead. In fact, the physician, dietician, or nurse in charge of an institutionalized patient can easily complete the MNA with a minimal risk of bias.

The MNA-SF: a nutritional screening tool

Given the adverse consequences of potential risk of malnutrition or malnutrition, it is clinically important to detect patients with this condition as early as possible. In hospitalized older patients, low MNA scores predict adverse outcomes. Thus, earlier identification of hospitalized patients at risk of malnutrition using the MNA-SF could facilitate timely initiation of nutritional support. Moreover,
MNA-SF can be used as a first step for screening preoperative patients, and can be used as an efficient screening tool for community-dwelling older people undergoing CGA.

The MNA-SF maximum score is 14. When the score of the MNA-SF is greater than 12, the patient has a satisfactory nutritional status. At this stage, it is important to give nutritional advice even if no signs of malnutrition are present, to follow the patient’s weight regularly at routine visits (usually every month) and to complete the MNA-SF at regular intervals (each three or six months), independently of the setting. Nutritional assessment and eventual intervention should be
proposed if weight loss is documented. If the score is less than 12, the second part of the MNA should be completed to establish the presence of malnutrition and obtain the malnutrition indicator score to be used for proposing and afterwards guiding nutritional interventions.

1) A score of 23.5 or higher classifies an individual as well-nourished. As mentioned above, and similarly, when a score greater of 12 in the MNA-SF is found, no specific follow-up is needed except to measure the person’s weight regularly at routine visits, complete the MNA at regular intervals and provide general nutritional counselling. Detailed nutritional evaluation and, if needed, nutritional intervention should be given if significant weight loss is documented or if the MNA score decreases during follow-up. In all cases, nutritional advice should be based upon the basic rules of a balanced diet (recalling the recommended intake frequencies of daily fruits and vegetables, starchy foods, dairy products, meats, fish, products of the sea and eggs, with the recommendation of not over-using fat contents and sweetened products), to perform regular daily physical activity and maintain good hydration.

2) Scores between 17 and 23.5 indicate that an individual is at risk of malnutrition. Nutritional intervention is always indicated for an MNA <23.5 and should start as soon as possible before the associated disorders (like functional impairment) become irreversible. Based upon CGA, cognitive, functional, nutritional and social status of the patient at risk of malnutrition should be obtained. A detailed nutritional evaluation should include the analysis of a three-day food-intake record, revision of the medical history, evaluating previous and current diseases and treatments, checking oral hygiene and the presence of swallowing impairment. A specific nutritional intervention program should be implemented, based on the impairments found after assessment by CGA and the MNA (items presenting loss of points). The key benefit of the MNA is that it has the capacity to detect older people at risk of malnutrition even before severe changes in weight or in albumin levels occur. The use of oral supplementation (OS) should be evaluated and could be implemented when the risk of malnutrition is present. Concentrated formulas increasing total intake of calories, proteins or micronutrients, can be used to improve nutritional status. Nutritional counselling, as in the previous stage, should always be provided.
3) Scores of less than 17 usually indicate that individuals have a protein-caloric malnutrition. At this stage, it is important to quantify the severity of the malnutrition by measuring biochemical parameters (such as plasma level albumin or transthyretin), evaluating a three-day record of food intake and measuring anthropometric features (such as weight, mid-arm and calf-circumference and skinfolds). Nutritional intervention is clearly indicated and should be based on achievable objectives established after a detailed CGA. No nutritional intervention should be started without setting specific and reasonable goals in advance. It will be necessary to use the oral route as long as possible by improving the total intake of calories and prescribing OS with proteins and micronutrients when needed.

The MNA: guiding nutritional intervention

The MNA is not only a tool for detecting malnutrition but it also guides nutritional interventions. Interventions studies with increased food choices or with nutritional supplements demonstrate that timely intervention stops weight loss in older people who are at risk of malnutrition or undernourished. Identifying the major contributing causes of malnutrition and critically reviewing diet should allow for targeted corrective measures. It is necessary to look carefully at where the patient loses points on the MNA, and propose guided interventions in order to correct them. Additionally, the proposed intervention also depends on the setting of the patient. In community-dwelling older people, if the person only takes two meals daily or fewer prepared complete meals, simple corrective measures can be taken, such as providing a nutrition programme, helping with shopping and cooking, providing meals-on-wheels, or providing adaptive cooking tools. Nutritional guidance will be given if patients do not consume some foodgroups or if they do not drink enough water. In hospitalized patients, depending on current disease, those with malnutrition or at risk of malnutrition can benefit from temporary OS during the length of the hospitalization. At discharge, long-term OS needs specific follow-up and regular reassessment at the outpatient consultation, taking into account the nutritional goals established during hospitalization. In institutionalized patients, nutritional interventions like supplements or buffet dining may be effective. Implementation of a dietary programme consisting of an increased protein and energy content of meals, adapting meals to oral health, additional help during meals, and dietary supplements between meals, may result in improved or stabilized nutritional status and weight gain. In institutionalized older people, environmental changes, for example using tables that allow the supervision of more than one resident at a time, can help increase the input of health-care workers at mealtimes. A favourable atmosphere, family-style meals and a homelike environment have proved effective, not only for increasing energy intake and decreasing the risk of malnutrition but also for maintaining the quality of life, physical performance and body weight of nursing-home residents, and consequently increasing the MNA score during the nutritional intervention follow-up if it is proven to be effective. If patients present with pressure ulcers or skin breaks, an increased intake of calories, proteins and micronutrients with OS will be needed and nutritional intervention guided by the MNA should be implemented.

Impaired cognitive function makes the need for assistance imperative in all activities of everyday life, particularly assistance during mealtimes. In community-dwelling older people suffering from Alzheimer’s disease (AD), home-support services, when needed, should be implemented as soon as possible, even starting at the mild stages of the disease, in order to prevent further functional decline and prevent institutionalization. As shown by Riviere et al. home-based programmes of nutritional education for caregivers of AD patients may have positive effects on weight and cognitive function. In institutionalized patients suffering from dementia, behavioural and psychological symptoms, such as exhausting wandering or food and eating behavioural disorders, should be evaluated as possible causes of malnutrition. Nutritional interventions in AD patients have been shown to reduce morbidity and mortality. Polypharmacy identified by MNA might be one of the causes of anorexia and malnutrition. Interventions should be directed to reduce this polypharmacy if possible. If the patient presents with anorexia, it will be necessary to search for any possible somatic cause.

The aim of nutritional intervention is to provide sufficient nutrients to cover daily needs, using OS
if necessary. As shown by Vellas et al., nutritional intervention is indicated for an MNA of 23.5 or lower and should start as soon as possible before the associated functional decline becomes irreversible.33 In a study performed with a cohort of 573 AD-affected older people, an MNA of less than 23.5 was associated with an increased risk of mortality after two years of follow-up, presenting a relative risk of 2.74 (95%CI 1.58–4.75) and an increased risk of institutionalization of 1.92 (95%CI 1.24–2.93).33 Many studies have shown that OS improves biochemical parameters and anthropometric measures in the majority of malnourished or at risk of malnutrition patients.34–37 Additionally, in these studies, older people improved or maintained their MNA scores after nutritional intervention, suggesting that the MNA can be used for evaluation if nutritional-intervention strategies are successful during the follow-up period. Thus, the patient’s weight should be assessed monthly and the MNA completed regularly every three months. Moreover, the MNA-guided nutritional intervention has also demonstrated to be cost-effective.38,39

The MNA in different clinical settings
Numerous studies have evaluated the prevalence of malnutrition using the MNA in different clinical settings, showing the excellent acceptability and validity of the tool in all these settings. As shown in Table 1, Guigoz et al. evaluated the prevalence of malnutrition and risk of malnutrition in different settings with two systematic revisions of the literature. The main finding was a ‘setting-related’ prevalence of malnutrition and risk of malnutrition with huge differences in between the settings.16,20 The large variability resulted mainly from the difference in levels of dependence and health status among the older people living in retirement homes, nursing homes, or long-term care facilities. In community-dwelling elderly individuals the prevalence of malnutrition (21 evaluated studies, n = 14149) was 2% (range 0–8%) and risk of malnutrition was 24% (range 8–76%); in outpatient and home-care patients (25 evaluated studies, n = 3119) the prevalence of malnutrition was 9% (range 0–30%) and risk of malnutrition 45% (range 8–65%); in hospitalized elderly patients (35 evaluated studies, n = 8596), the prevalence of malnutrition was 23% (range 1–74%) and risk of malnutrition was 46% (range 8–63%); in institutionalized elderly patients (32 evaluated studies, n = 6821) the prevalence of malnutrition was 21% (range 5–71%) and risk of malnutrition was 51% (range 27–70%).

Finally, in cognitively impaired older people (11 evaluated studies, n = 2051), who were screened using the MNA, the prevalence of malnutrition was 15% (range 0–62%), risk of malnutrition was 44% (range 19–87%) and well-nourished was 41% (range 0–80%).

The MNA as part of Comprehensive Geriatric Assessment
CGA was created to detect disabilities and deficiencies in older people in order to prevent further decline by implementing interventions that targeted these deficiencies. It is proven that CGA improves diagnostic accuracy and long-term prognosis for elderly patients.40–41 CGA has been used in a

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Table 1. Prevalence of malnutrition in different settings

<table>
<thead>
<tr>
<th>Clinical Setting</th>
<th>% MNA &lt; 17 (malnutrition)</th>
<th>% MNA &lt; 23.5 (at risk of malnutrition)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community-dwelling</td>
<td>1% (range 0–3%)†</td>
<td>29% (range 15–44%)†</td>
</tr>
<tr>
<td>Home Care provided</td>
<td>2% (range 0–8%)**</td>
<td>24% (range 8–76%)**</td>
</tr>
<tr>
<td>Outpatients</td>
<td>4% (range 0–13%)†</td>
<td>33% (range 8–63%)†</td>
</tr>
<tr>
<td>Hospitalized</td>
<td>9% (range 0–30%)**</td>
<td>45% (range 8–65%)**</td>
</tr>
<tr>
<td>Institutionalized</td>
<td>20% (range 7–32%)†</td>
<td>49% (range 25–60%)†</td>
</tr>
<tr>
<td></td>
<td>23% (range 1–74%)**</td>
<td>46% (range 8–63%)**</td>
</tr>
<tr>
<td></td>
<td>37% (range 5–71%)†</td>
<td>44% (range 26–67%)†</td>
</tr>
<tr>
<td></td>
<td>21% (range 5–71%)**</td>
<td>51% (range 27–70%)**</td>
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</table>

†Source: Guigoz et al.20
**Source: Guigoz et al.16
variety of settings to detect medical, psychological, social and environmental problems of elderly people to identify unmet needs and to prevent or treat disability by implementing specific interventions. Initially, nutritional assessment was not part of the usual CGA, which included primarily assessment of cognitive functions (mostly by MMSE), assessment of physical performance by evaluating the activities of daily living (ADL), the instrumental activities of daily living (IADL), gait and balance impairments using the Tinetti scale, and mood was normally assessed using the Geriatric Depression Scale (GDS). The complexity of nutritional assessment was one of the major drawbacks for the inclusion of the domain in CGA, even if the presence of malnutrition in the evaluated geriatric population was important. Since its inception, the MNA has helped to include nutritional assessment in current CGA, due to its applicability and wide acceptance. At the present time, nutritional evaluation, generally assessed using the MNA, is an essential part of CGA.

The MNA in clinical research

The MNA has been used in hundred of studies in a wide range of different settings and in many countries. Many literature reviews concerning nutritional assessment tools in elderly people, and in particular the MNA, have been published. Guigoz et al. in 2006 published a systematic review on observational and interventional studies concerning nutritional assessments of over 30,000 elderly persons. It showed that the prevalence of malnutrition and risk of malnutrition was related to the study setting and was modified by the presence of cognitive impairment, but also that the MNA had excellent acceptance in different settings. With the more general use of the MNA as a nutritional assessment tool, specific concerns related to the use of the MNA have been evaluated by many studies. Clinical research involving the MNA has proved to be useful for better understanding of the physiopathology of malnutrition in older people, and much clinical progress has been made. Several studies have demonstrated that the MNA can identify those at risk for malnutrition before biochemical or weight changes appear, and also that timely intervention can stop weight loss in elderly people at risk of malnutrition or already malnourished. Intervention studies have shown associations with improvements in MNA scores. The MNA and MNA-SF were found to be sensitive, specific, and accurate in identifying nutritional risk. Sieber et al. demonstrated that, 15 years after its introduction, the MNA is the gold standard for nutritional assessment in ambulatory community-living elderly people and those in long-term care facilities. Sieber compared the MNA to the Nutrition Risk Screening (NRS). Vellas et al. highlighted the usefulness of the MNA, as a simple nutritional assessment tool, in clinical practice to measure nutritional status in older people and in nutritional intervention follow-up for evaluating the success of the intervention. Many studies found that the MNA was correlated with clinical nutritional assessment and to objective parameters of nutritional status such as serum albumin, BMI triceps skinfold, caloric intake and vitamin status. Peppersack et al. used the MNA to establish a biochemical threshold for malnutrition by evaluating prealbumin (transthyretin) in relation to the MNA score. In the same study, evidence was found that malnutrition detected by the MNA appeared before an alteration in the biochemical parameters was present. Hudgens et al. evaluated immunity in older people and found a direct relationship between the MNA score and immunity impairment and also showed that whole blood lymphocyte proliferation was significantly lower in malnourished older people identified by the MNA. Low MNA scores have also shown to predict a greater incidence of adverse clinical outcomes during hospitalization and mortality. The MNA has been used successfully in many interventional studies in patients who are ill or frail. The MNA is not only a tool for detecting malnutrition or risk of malnutrition but it also has been used as a guide for nutritional interventions. Finally, many studies have demonstrated that cognitive functions were associated with lower MNA or MNA-SF scores and that in patients suffering from dementia, even in moderate or severe stages, nutritional education was effective. The MNA appeared to be a valid and accepted assessment tool for clinical studies involving demented patients. A recent literature review concerning 42 studies with institutionalized older people, performed by Harris et al., compared different nutritional assessment tools. BMI was the most frequently used parameter for nutritional assessment (22 studies), followed by the MNA,
Table 2. Sensitivity and specificity of the Mini Nutritional Assessment, MNA, and the MNA short form, MNA-SF, in different clinical settings

<table>
<thead>
<tr>
<th>MNA</th>
<th>SENSITIVITY</th>
<th>SPECIFICITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harris et al., 200854</td>
<td>89%</td>
<td>90%</td>
</tr>
<tr>
<td>Ferreira et al., 200855</td>
<td>89%</td>
<td>82%</td>
</tr>
<tr>
<td>Elkam et al., 200753</td>
<td>84%</td>
<td>36%</td>
</tr>
<tr>
<td>Kuzuya et al., 200556</td>
<td>81%</td>
<td>86%</td>
</tr>
<tr>
<td>Delacorte et al., 200466</td>
<td>100%</td>
<td>74.3%</td>
</tr>
<tr>
<td>Visvanathan et al., 200457</td>
<td>89.5%</td>
<td>87.5%</td>
</tr>
<tr>
<td>Guigoz et al., 199558</td>
<td>96%</td>
<td>98%</td>
</tr>
</tbody>
</table>

MNA-SF SENSITIVITY SPECIFICITY

| Wkby et al., 200859 | 89%        | 90%         |
| Charlton et al., 200770 | 100%       | 94.6%       |
| Kuzuya et al., 200556 | 85.9%      | 84%         |
| Visvanathan et al., 200457 | 92.5%     | 37.8%       |
| Coheny et al., 200117 | 85.6%      | 88.8%       |
| Rubenstein et al., 200113 | 97.9%      | 100%        |

MNA = Mini Nutritional Assessment and MNA-SF = Short Form of the MNA.

which was used for nutritional assessment in 12 studies. The other assessment tools used were: comparison of the body weight against standard or ideal body weight, weight loss, biochemical parameters (albumin, prealbumin, transferrin and retinol-binding protein), anthropometric values (mid-arm and calf-circumference, skinfold), and the Subjective Global Assessment (SGA) tool. According to the MNA, malnutrition was observed in 2%–38% and a risk of malnutrition in 37%–62%. One of the main issues in clinical research is to evaluate whether a nutritional assessment tool has the capacity to identify malnourished older people as malnourished and normal older people as normal; in other words evaluate the sensitivity and specificity of a tool. A high sensitivity is necessary for screening tests (MNA-SF) and a high specificity is necessary in order to confirm the diagnosis. Table 2 gives a summary of the sensitivity and specificity obtained using the MNA and the MNA-SF,15,17,62–70

Tables 3 and 4 summarize recent publications of studies performed in community and clinical settings and in older persons with specific disease. (Table 3: 62–90; Table 4: 91–102) The studies using the MNA provided comparative and comprehensive data on the prevalence of malnutrition and risk of malnutrition in clinical settings, including hospitals and nursing homes, and in community settings around the world, and show a very similar trend. The observational studies show the high prevalence of malnutrition and risk of malnutrition in elderly persons especially in hospitalized and institutionalized patients.

New challenges for the MNA

MNA offers opportunities in clinical research. As demonstrated in more than 200 publications, the MNA is a very useful tool for clinical research. The International Association of Gerontology/International Academy of Nutrition and Aging (IAGG-IANA) Task Force on Minimum Data Set recommended the MNA for nutritional studies in elderly patients.103 A recent consensus concerning research in older people has proposed a tool to harmonize future clinical trials in the field of geriatric medicine. This tool, named the GMDS-25, has been created in order to become a reference minimum data set to be included in all clinical studies involving older subjects. It consists of different parameters of assessment: general parameters, cardiovascular risk factors, functional status, cognitive and psychological status, nutritional status, biological parameters and social status. The nutritional assessment is based on the MNA-SF followed by MNA if at risk, BMI, and weight loss (4% in one year or 5 kg in six months).104

One of the future challenges is to integrate the MNA in research protocols not only as a nutritional assessment tool. The MNA as an inclusion or exclusion criterion could be useful for the homogenization of samples or useful as an outcome criterion in order to permit meta-analyses.

Another challenge is to evaluate other types of disorders or syndromes using the MNA. It has been proposed that the MNA could eventually measure AD severity, frailty or the indication for tube-feeding by changes the thresholds and the study populations to which it is directed. Future research will need to demonstrate all these hypothesis.

Conclusion

The MNA provides a number of unique opportunities useful for practice. It is important to sensitize health professionals to the problem of malnutrition
Table 3. Prevalence of malnutrition in elderly determined by the MNA

<table>
<thead>
<tr>
<th>Author, Year Reference</th>
<th>Type of study</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harris DG, 2008</td>
<td>Observational study, N = 100</td>
<td>Sensitivity = 80%; Specificity = 90%; PPV = 0,47; NPV = 0,98</td>
</tr>
</tbody>
</table>
| Wikby K, 2008          | Cross-sectional study, N = 127    | Agreement level between the 2 assessment methods (MNA by authors and MNA by nurses) was 62%  
Comparison between MNA-SF and full MNA: agreement of 87% between the MNA-SF and the full MNA to classify older people as malnourished; sensitivity of 89%; specificity of 82%; PPV was 92% |
| Hengstermann S, 2008   | Cross-sectional study, N = 808    | The score of the MNA and MNA-SF correlated with r = 0,910  
Correlation between MNA and MNA-SF group classification = 83% |
| Gil-Montoya JA, 2008   | Cross-sectional study, N = 2860   | Mean MNA score = 24  
3.5% were malnourished; 31.5% were at risk of malnutrition; 65% were well-nourished |
| Formiga F, 2008        | Observational study, N = 140      | Investigation into the rate of falls  
No statistically significant association was found between the fallers and the non-fallers according to the MNA-SF |
| Cayac Lantigua M, 2007 | Observational study, N = 197      | MNA < 24 = 68%; MNA < 17 = 19.3%  
MNA scores <24 were concentrated in neurological disorders (80%), Neoplasms and lymphoproliferative processes (77.8%), heart and blood vessels diseases (74.2%), gastrointestinal disorders (70.6%).  
Patients with the lowest scores associated to lowest values of anthropometric and biochemical markers  
MNA scoring was 80% coincident with the nutritional diagnostic |
| Tsai AC, 2007          | Observational study               | The MNA was effective in predicting 12-month follow-up mortality in cognition-normal elderly and in predicting 6-month follow-up mortality in cognition-impaired elderly |
| Tsai AC, 2007          | Observational study, N = 1583 M; 1307 W; Age ≥ 65; In home | Substitution of population-specific anthropometric cut-points (BMI, mid-arm circumference and calf circumference) for respective values resulted of lowered prevalence of malnutrition |
| Feldblum I, 2007       | Observational study, N = 259      | Mean MNA score = 19.5  
18.5% were malnourished; 81.5% were at risk of malnutrition  
The patients who were malnourished were less educated, had higher depression, lower cognitive and physical functioning, had higher chewing problems, higher nausea and vomiting |
Table 3. (Continued)

<table>
<thead>
<tr>
<th>Author, Year Reference</th>
<th>Type of study</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suominen MH, 2007&lt;sup&gt;99&lt;/sup&gt;</td>
<td>Cross-sectional study, N = 1043 Mean age = 81 Long-term care hospitals</td>
<td>According to the nurses: 15% were malnourished According to the MNA: 56.7% were malnourished patients considered to have normal nutrition by the nurses: 50.2% were malnourished and 46.7% were at risk of malnutrition</td>
</tr>
<tr>
<td>Norman K, 2007&lt;sup&gt;79&lt;/sup&gt;</td>
<td>Observational study, N = 112 Mean age = 85 Nursing homes</td>
<td>19.6% were well-nourished Handgrip strength, knee-extension strength, Barthel’s index and phase angle decreased with decreasing MNA</td>
</tr>
<tr>
<td>Charlton KE, 2007&lt;sup&gt;70&lt;/sup&gt;</td>
<td>Cross-sectional study, N = 283 Mean age = 72 Institutionalized (15%); community-dwelling (83%)</td>
<td>Mean MNA = 23 5% were malnourished; 50-4% were at risk of malnutrition; 44.4% were well-nourished The MNA was positively and significantly associated with anthropometric values, cognitive function MNA-SF vs full MNA: Sensitivity = 100%; Specificity = 94.6% MNA-SF was strongly correlated with the full MNA (r = 0.811; p &lt; 0.0001) MNA-SF was associated with cognitive function score (r = −0.31; p &lt; 0.0001)</td>
</tr>
<tr>
<td>Kostka T, 2007&lt;sup&gt;80&lt;/sup&gt;</td>
<td>Observational study, N = 300 Age = 66–79 Community-dwelling persons</td>
<td>Mean MNA = 24 MNA was associated with physical activity: Mobility (W: 0.86; p &lt; 0.01-M:0.83; p &lt; 0.05) Usual activity (W: 0.81; p &lt; 0.001-M: 0.70; p &lt; 0.001)</td>
</tr>
<tr>
<td>Espaulella J, 2007&lt;sup&gt;81&lt;/sup&gt;</td>
<td>Prospective longitudinal cohort study, N = 165 Mean age = 83 Hospitals</td>
<td>Mean MNA = 16 Six-month mortality = 29.1% MNA was associated with mortality</td>
</tr>
<tr>
<td>Venzin RM, 2007&lt;sup&gt;82&lt;/sup&gt;</td>
<td>Prospective study, N = 430 Mean age = 63 Hospitals</td>
<td>The agreement between the clinical judgment and the MNA was significant (r = 0.73; p &lt; 0.001)</td>
</tr>
<tr>
<td>Bauer JM, 2007&lt;sup&gt;83&lt;/sup&gt;</td>
<td>Cross-sectional study, N = 121 Mean age = 80 Geriatric hospital</td>
<td>MNA identified 70% with malnutrition or at-risk No correlation between MNA and basal ghrelin level was found</td>
</tr>
<tr>
<td>Formiga F, 2007&lt;sup&gt;84&lt;/sup&gt;</td>
<td>Cohort study, N = 186 Mean age = 93 At home (74%); Institutionalized (26%)</td>
<td>Rate of mortality = 19.3% MNA-SF was associated with mortality in multivariate analysis</td>
</tr>
<tr>
<td>Ghisla MK, 2007&lt;sup&gt;85&lt;/sup&gt;</td>
<td>Observational study, N = 2650 Age ≥ 60 Geriatric rehabilitation</td>
<td>In patients with MMSE ≥ 18, better nutritional status according to the MNA-SF emerged as a factor associated with functional improvement</td>
</tr>
<tr>
<td>Nijs KA, 2006&lt;sup&gt;86&lt;/sup&gt;</td>
<td>Randomized controlled trial, N = 178 Mean age = 77 Nursing homes</td>
<td>The percentage of residents in the intervention group classified by the MNA as malnourished decreased from 17% to 14%, whereas this percentage increased from 11% to 23% in the control group</td>
</tr>
<tr>
<td>Wojszel ZB, 2006&lt;sup&gt;87&lt;/sup&gt;</td>
<td>Observational study, N = 100 Age ≥ 65 Nursing homes</td>
<td>Malnutrition was associated with: chewing problems; ADL dependence; limited mobility; dementia; cerebral stroke; nursing homes; depression</td>
</tr>
</tbody>
</table>
Table 3. (Continued)

<table>
<thead>
<tr>
<th>Author, Year</th>
<th>Reference</th>
<th>Type of study</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kabir ZN, 2006</td>
<td>88</td>
<td>Observational study, N = 457</td>
<td>26% were malnourished; 62% were at risk of malnutrition</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mean age = 69 Home (population in rural Bangladesh)</td>
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</tr>
<tr>
<td>Wikby K, 2006</td>
<td>89</td>
<td>Cohort study, N = 127</td>
<td>Cohort 2: people who were newly admitted to these community residential homes</td>
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<tr>
<td></td>
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<td>Age ≥ 65 community residential homes</td>
<td>Cohort 1: previous study performed in the same municipality 4 years earlier</td>
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<td>32% were malnourished in Cohort 2; 38% were malnourished Cohort 1</td>
</tr>
<tr>
<td>Soini H, 2006</td>
<td>90</td>
<td>Observational study, N = 178 Elderly patients</td>
<td>50% were at risk of malnutrition; 3% were malnourished</td>
</tr>
<tr>
<td></td>
<td></td>
<td>At home</td>
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</tbody>
</table>

MNA: Mini Nutritional Assessment; MNA-SF: Mini Nutritional Assessment Short Form; W: Women; M: Men; PPV: Positive Predictive Value; NPV: Negative Predictive Value; BMI: Body Mass Index; HR: Hazard Ratio; CI: Confidence Interval; MMSE: Mini Mental State Examination.

Table 4. Prevalence of malnutrition associated with other diseases

<table>
<thead>
<tr>
<th>Authors, Year</th>
<th>Reference</th>
<th>Type of study</th>
<th>Disease</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zekry D, 2008</td>
<td>91</td>
<td>Prospective study, N = 349 Rehabilitation and Geriatric hospital</td>
<td>Dementia (46.1% cognitively normal; 10.6% MCI; 43.3% dementia)</td>
<td>MNA-SF decreased with cognitive status (p = 0.001)</td>
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<td></td>
<td></td>
<td>Mean age = 85</td>
<td></td>
<td>No association was found between MNA-SF and type of dementia</td>
</tr>
<tr>
<td>Hengsterman S, 2007</td>
<td>92</td>
<td>Prospective study, N = 484 Hospitals</td>
<td>Pressure ulcer (PU) Prevalence = 16.7%</td>
<td>PU patients: 2.6% were well-nourished; 39.5% were malnourished</td>
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<tr>
<td></td>
<td></td>
<td>Mean age = 80</td>
<td></td>
<td>Non-PU patients: 23.6% were well-nourished; 16.6% were malnourished</td>
</tr>
<tr>
<td>Riccio D, 2007</td>
<td>93</td>
<td>Prospective study, N = 47 Institutionalized</td>
<td>Dementia</td>
<td>MMSE low score was correlated with a worse MNA (HR = 19.5; p = 0.003)</td>
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<tr>
<td></td>
<td></td>
<td>Mean age = 84</td>
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<tr>
<td>Schiffman SS, 2007</td>
<td>94</td>
<td>Cohort study, N = 107 Elderly patients</td>
<td>Cancer with chemotherapy</td>
<td>Intervention group received flavour enhancement, chemosensory education and nutritional information</td>
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<td>Constipation 55.3% of all residents received laxatives regularly</td>
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<td>After 8-month follow-up interventional group had better scores on the MNA, had better self-reported taste and smell perception than the control group</td>
</tr>
<tr>
<td>Hosia-Randell H, 2007</td>
<td>95</td>
<td>Cross-sectional study, N = 1987 Nursing homes</td>
<td>Constipation 55.3% of all residents received laxatives regularly</td>
<td>Poor MNA score was associated with regular laxative use in univariate analysis (OR = 1.51; 95%CI = 1.19–1.93)</td>
</tr>
<tr>
<td>Authors, Year Reference</td>
<td>Type of study</td>
<td>Disease</td>
<td>Results</td>
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<tr>
<td>Olofsson B, 200796</td>
<td>Randomized controlled trial, N = 157 Hospitals&lt;br&gt;Age ≥ 70</td>
<td>Femoral neck fracture</td>
<td>Intervention group received a nutritional assessment to detect nutrition deficiencies, protein-enriched meals and protein drinks&lt;br&gt;Mean MNA: Intervention group: 23; Control group: 22&lt;br&gt;Risk of malnutrition or malnutrition on admission: Intervention group: 58%; Control group: 64%&lt;br&gt;Postoperative complications: Fewer patients in the intervention group developed delirium (46 vs 54 in the control group; p = 0.022) and the number of days with delirium was significantly lower (2.3 days vs 8 in the control group; p &lt; 0.001)&lt;br&gt;Half as many in the intervention group developed pressure ulcers (p = 0.054)&lt;br&gt;The length of stay for the intervention group was shorter (27 days vs 40; p = 0.019)</td>
<td></td>
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<tr>
<td>Cabrera MA, 200797</td>
<td>Cross-sectional study, N = 267 Age = 60–74 At home</td>
<td>Depression (identified as regular use of antidepressives or/and scores higher than 5 points on the GDS)</td>
<td>21.7% were at risk of malnutrition or malnourished&lt;br&gt;Depression was identified in 24.3%&lt;br&gt;Nutritional deficit (MNA &lt; 24) was associated significantly with depression even after adjustment (OR = 4.38; 95% CI = 2.23–8.64; p &lt; 0.001)</td>
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<tr>
<td>Hassen TA, 200798</td>
<td>Prospective study, N = 68 Mean age = 71 Hospitals</td>
<td>Vascular surgery&lt;br&gt;Open AAA (n = 35)&lt;br&gt;EVAR (n = 16)&lt;br&gt;Lower limb revascularization (n = 17)</td>
<td>MNA:&lt;br&gt;Open AAA: 24 were well-nourished; 6 were at risk of malnutrition&lt;br&gt;EVAR: 15 were well-nourished; 1 was at risk of malnutrition&lt;br&gt;Lower limb revascularization: 9 were well-nourished; 8 were at risk of malnutrition&lt;br&gt;Using the MNA neither SIRS severity nor sepsis occurrence differed significantly between well-nourished patients and those at risk</td>
<td></td>
</tr>
<tr>
<td>Authors, Year Reference</td>
<td>Type of study</td>
<td>Disease</td>
<td>Results</td>
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<tr>
<td>Suominen MH, 2007&lt;sup&gt;99&lt;/sup&gt;</td>
<td>Randomized controlled trial, N = 40; Mean age = 85; Nursing homes</td>
<td>Dementia (moderate or severe dementia)</td>
<td>Group 1: assessment of energy and nutrient intake before and after nutritional education Group 2: assessment of nutritional status with MNA before and after nutritional education Group 1: Before intervention the energy intake was on average 1230 kcal/d After intervention the energy intake was 1487 kcal/d (p ≤ 0.001) Mean energy intake increased 21% Group 2: Before intervention: none was well-nourished; 89% were at risk of malnutrition; 11% were malnourished After intervention: 16% well-nourished; 63% were at risk of malnutrition; 21% were malnourished</td>
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</tr>
<tr>
<td>Formiga F, 2006&lt;sup&gt;100&lt;/sup&gt;</td>
<td>Prospective study, N = 88; Mean age = 79; Hospitalized</td>
<td>New diagnosis of heart failure (HF)</td>
<td>Mean MNA-SF = 11 27% died during the first year of follow-up MNA-SF was not associated with HF related mortality or readmission</td>
<td></td>
</tr>
<tr>
<td>Soini H, 2006&lt;sup&gt;90&lt;/sup&gt;</td>
<td>Cross-sectional study, N = 3480; Elderly patients Nursing homes (n = 2036); Long-term care wards (n = 1444)</td>
<td>Dental problems</td>
<td>Patients living in nursing homes: 11% well-nourished; 60% were at risk of malnutrition; 29% were malnourished Patients living in long term care wards: 3% well-nourished; 40% were at risk of malnutrition; 57% were malnourished</td>
<td></td>
</tr>
<tr>
<td>Salminen H, 2006&lt;sup&gt;102&lt;/sup&gt;</td>
<td>Cross-sectional study, N = 351; Mean age = 73+/−2.3; Free-living</td>
<td>Osteoporosis</td>
<td>Median MNA = 27; 7.4% were at risk of malnutrition Osteoporosis of the femoral neck was observed by 22% Fracture after the age of 50 reported by 31% Low score of MNA increased risk of having osteoporosis in the femoral neck and/or total hip (for MNA &lt; 27; OR = 2.09; 95%CI = 1.14–3.83)</td>
<td></td>
</tr>
</tbody>
</table>

MNA: Mini Nutritional Assessment; MNA-SF: Mini Nutritional Assessment Short Form; W: Women; M: Men; CI: Confidence Interval; MMSE: Mini Mental State Examination; AD: Alzheimer's disease; OR: Odds Ratio; GDS: Geriatric Depression Scale; AAA: Aortic Abdominal Aneurysm; EVAR: Endovascular Abdominal Aortic Aneurysm; SIRS: Systemic Inflammatory Response Syndrome.
in older people, especially the frail and ill. Up to date, the MNA is the most validated and accepted screening tool for geriatric patients, no matter the setting, with clearly defined thresholds. It is the most efficient, simple and appropriate nutritional assessment tool for older people: BMI cannot differentiate thin with good nutritional status or obese with malnutrition; albumin plasma-level is not useful in the presence of dehydration or an inflammation; previous weight (which is often difficult to determine) is not necessary; the MNA can detect malnutrition or risk of malnutrition before severe weight or albumin loss is present; the MNA allows nutritional intervention and follow-up; it can be completed easily by a physician, a dietician, a nurse or generalist assessor in few minutes; and it is acceptable to patients. The MNA not only detects malnutrition but also favours early nutritional intervention in order to improve nutritional parameters and especially improve quality of life.

References


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