Original Article

Cut-off scores for the Minimal Eating Observation and Nutrition Form – Version II (MEONF-II) among hospital inpatients

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Abstract

Background and objective: The newly developed Minimal Eating Observation and Nutrition Form – Version II (MEONF-II) has shown promising sensitivity and specificity in relation to the Mini Nutritional Assessment (MNA). However, the suggested MEONF-II cut-off scores for deciding low/moderate and high risk for undernutrition (UN) (>2 and >4, respectively) have not been decided based on statistical criteria but on clinical reasoning. The objective of this study was to identify the optimal cut-off scores for the MEONF-II in relation to the well-established MNA based on statistical criteria.
Design: Cross-sectional study.
Methods: The study included 187 patients (mean age, 77.5 years) assessed for nutritional status with the MNA (full version), and screened with the MEONF-II. The MEONF-II includes assessments of involuntary weight loss, Body Mass Index (BMI) (or calf circumference), eating difficulties, and presence of clinical signs of UN. MEONF-II data were analysed by Receiver Operating Characteristics (ROC) curves and the area under the curve (AUC); optimal cut-offs were identified by the Youden index (J = sensitivity + specificity–1).
Results: According to the MEONF-II, 41% were at moderate or high UN risk and according to the MNA, 50% were at risk or already undernourished. The suggested cut-off scores were supported by the Youden indices. The lower cut-off for MEONF-II, used to identify any level of risk for UN (>2; J = 0.52) gave an overall accuracy of 76% and the AUC was 80%. The higher cut-off for identifying those with high risk for UN (>4; J = 0.33) had an accuracy of 63% and the AUC was 70%.
Conclusions: The suggested MEONF-II cut-off scores were statistically supported. This improves the confidence of its clinical use.

Keywords: *cut-off scores*; *MEOF*; *MNA*; *MEONF*; *nutritional screening*; *ROC-curve*

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Undernutrition (UN) is associated with poorer health, compromised ability to recover from medical conditions, and increased mortality (1). People at risk for or with manifest UN therefore need to be identified in order to initiate prevention or treatment. The most well-established tool for nutritional screening is the mini nutritional assessment (MNA), which consists of two parts: the first part (short form) is an initial screening tool (MNA-SF), whereas the full MNA provides a more detailed assessment (2, 3). Other examples of nutritional screening tools include the Nutritional Risk Screening (NRS) 2002 (4), Malnutrition Universal Screening Tool (MUST) (5), Nutritional Form for the Elderly (NUFFE) (6), and the recently developed minimal eating observation and nutrition form – version II (MEONF-II) (7, 8).

MEONF-II is based within an interdisciplinary nursing framework (7), including description of mealtime problems that are associated with needs for nutritional interventions and clinical outcome (9, 10). In addition to mealtime problems, classical signs of UN, i.e. low BMI and unintentional weight loss (11) are included in the

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instrument in order to facilitate detection of problems, take preventive actions, or initiate treatment (7). The rationale for developing the MEONF-II was that earlier instruments do not at all, or to a limited extent, take eating difficulties into account in assessing nutritional risk. Furthermore, as nutritional screening typically is conducted by nurses it is important that the instrument is experienced as user-friendly and relevant from the nurses' perspective in order to achieve a successful clinical implementation (7, 8).

In two previous studies, the sensitivity, specificity, and user-friendliness of the MEONF-II, MUST, and NRS-2002 in relation to the MNA were analysed among hospital inpatients (7, 8). Results suggested that the MEONF-II is easy and relatively quick to use, and its accuracy was favourable to that of the MUST (82 vs. 78%) (7) as well as to the NRS 2002 (68 vs. 55%). However, the MEONF-II cut-off scores used in the two studies (7, 8) were based on clinical reasoning, not on statistical criteria. Here we fill this gap by evaluating the MEONF-II cut-off scores in relation to the MNA classifications among hospital inpatients using statistical criteria. The primary aim was to identify the lower cut-off score for the MEONF-II; that is, the score that best separates those identified at risk for UN or being undernourished from those who are well-nourished according to the MNA. A secondary aim was to explore the higher cut-off score for the MEONF-II; that is, the MEONF-II cut-off for identifying UN (according to the MNA) among those at any risk according to the lower MEONF-II cut-off.

Present investigation

Materials and methods

The study included 187 hospital inpatients from two earlier studies (7, 8). Approval was obtained from the local ethics council and all participants provided informed consent. The first sample consisted of 100 orthopaedic, stroke, and cardiology inpatients aged 65 or older (7). The second sample consisted of 87 adult (18+ years old) inpatients (of whom 15 were <65 years old) receiving inpatient care at four hospital departments (stroke, surgery, orthopaedic, and geriatric medicine) (8).

Mini Nutritional Assessment (MNA)

The MNA was developed for use among elderly patients (≥65 years) (12). The full MNA consists of 18 items with a maximum possible total score of 30. The MNA score indicates three different levels of nutritional status: well-nourished (30–24 points), at risk for UN (23.5–17 points), and undernourished (<17 points) (13). The tool has been shown to have high sensitivity (96%), specificity (98%), and positive predictive value (PPV) (97%) when compared with extensive assessments of nutritional status (3) and has commonly been used as a comparator when testing other instruments (5–8, 14, 15). Here we used the full 18-item MNA as the comparator for determination of cut-off scores for the MEONF-II.

Minimal Eating Observation and Nutrition Form – Version II (MEONF-II)

MEONF was based on the minimal eating observation form – version II (MEOF-II; available from www.hkr.se/meof) (10, 16) that includes three components of eating (food intake, swallowing/mouth, and energy/appetite). MEONF-II also includes unintentional weight loss, low BMI (<20 for 69 years or younger, or <22 for 70 years or older) (17), or calf circumference <31 cms (7, 18), and the presence or absence of clinical signs of UN (7). The full instrument is available online at www.hkr.se/meonf. All items are scored one except for unintentional weight loss and energy/appetite, which are scored two since such problems are strong predictors of UN (10). MEONF-II yields a total score ranging from zero to eight. Based on clinical reasoning, it has been suggested that a score of zero to two represents low risk for UN, a score of three to four is considered a moderate risk, and a score of five or more as high risk for UN (7). MEONF-II has shown a sensitivity of 0.73, specificity of 0.88, PPV of 0.81, negative predictive value (NPV) of 0.82, and an accuracy of 0.82 when compared with the MNA among elderly (65+ years old) hospital inpatients (7). Among adult (18+ years old) hospital inpatients the sensitivity was 0.61, specificity 0.79, PPV 0.82, NPV 0.57, and accuracy was 0.68 when compared with the MNA (8).

Procedure

Following written and oral information about the studies and the included assessment methods, 10 registered nurses conducted nutritional assessments during lunch or dinner. Nine of them had special responsibility for nutrition at their respective wards and one had overall responsibility for the data collection (7, 8). For more detailed information see Westergren and colleagues (7, 8).

Power

With an expected sensitivity/specificity of 0.75, and a 40% (±10%) expected prevalence (7), a sample size around $n = 180$ would be adequate to estimate the sensitivity and specificity of a diagnostic test (19).

Analyses

Identification of optimal MEONF-II cut-off scores (for low vs. moderate/high risk for undernutrition and moderate vs. high risk for undernutrition, respectively) with the established MNA (full version) categorisations (well-nourished vs. at risk for undernutrition/undernutrition and well-nourished/at risk for undernutrition vs. undernutrition) as criteria was based on receiver operating characteristics (ROC) curves. In constructing a

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ROC-curve, sensitivity and specificity are determined for each possible cut-off point. The optimal cut-off point is where the overall number of errors (false-positives and false-negatives) are minimised (20). In addition, the area under the curve (AUC) was calculated for the ROC curves. The AUCs can range between 0 and 1; an AUC <0.5 indicates that a test performs worse than chance, whereas an AUC of 1 indicates perfect discrimination. For example, if the AUC is 0.8 and we randomly select two people, one who is undernourished and one who is not, the probability is 80% that the former will have higher score (here indicating higher risk) (20). The AUC should be ≥0.7 to be acceptable (21); AUCs between 0.7–0.9 and >0.9 are considered moderate and high, respectively (22). To select optimal cut-off scores, the Youden index (J = sensitivity + specificity-1) was calculated. The cut-off score associated with the highest J is considered to indicate the optimal cut-off point (23).

Finally, the identified cut-off scores were assessed regarding sensitivity, specificity, PPV, NPV, and accuracy. These indices provide values ranging from zero to one (or equivalently expressed as a percentage), where higher values are better (24, 25). The analyses were carried using PASW Statistics 18.0, MedCalc version 11.4.4.0, and GraphPad Instat version 3.06 for Windows.

Results

The mean age of the patients was 77.5 years and 57% were women. According to the previously suggested cut-off scores of the MEONF-II, 41% were at moderate/high UN risk; according to the MNA, 50% were at risk for/already undernourished (Table 1).

According to the Youden index, the optimal cut-off point for identifying those at any nutritional risk (at risk for undernutrition/undernutrition according to the MNA) was >2 points, with an AUC of 0.80 (95% CI, 0.73–0.85) (Table 2). After excluding those at no/low risk according to the MEONF-II, the optimal cut-off point for identifying those with UN according to the MNA was >4 according to the Youden index, with an AUC of 0.70 (95% CI, 0.57–0.80) (Table 3).

The lower and higher cut-off points had sensitivities of 67 and 75%, specificities of 85 and 58%, and accuracies of 76 and 63%, respectively (Table 4).

Table 1. Characteristics of the patients

	n = 187
Age, mean (SD)[a]	77.5 (11.6)
Min–Max	23–98
Gender, %	
Male	43
Female	57
Care setting, %	
Orthopaedic	30
Stroke	29
Cardiology	18
Geriatric	13
Surgery	10
Unintentional weight loss, %	35
Low BMI or calf circumference <31 cm, %[b]	29
Eating difficulties, %	
Food intake[c]	21
Swallowing/mouth[d]	9
Energy/appetite[e]	35
Clinical signs, %	29
Undernutrition risk according to the MEONF-II, %[f]	
No/low risk	59
Moderate risk	20
High risk	21
Undernutrition according to the MNA, %[g]	
Well-nourished	50
At risk for undernutrition	37
Undernutrition	13

[a]Fifteen patients were younger than 65 years.
[b]BMI <20 for ≤69 years or <22 for ≥70 years. Calf circumference replaced BMI in two patients.
[c]Includes sitting position, manipulate food on plate, conveying food to mouth.
[d]Includes chewing, coping with food in mouth, swallowing.
[e]Includes amount food eaten, energy to complete a meal, appetite.
[f]Minimal Eating Observation and Nutrition Form – Version II. Internal attrition n = 1.
[g]Mini Nutritional Assessment. Internal attrition n = 2.

Discussion

This study sought to determine optimal cut-off scores for the MEONF-II and found that previously suggested cut-off points based on clinical reasoning were statistically supported when using the MNA as the comparator criterion. The accuracies and AUCs found here were acceptable and indicate that the MEONF-II has sufficient ability to discriminate between patients with low, moderate, or high risk for UN. These observations provide additional support for the usefulness of the MEONF-II in research and clinical practice as an interpretable and user friendly interdisciplinary tool for identifying patients at risk for UN while also taking eating difficulties into account.

The sample size was calculated to achieve enough power in the statistical analyses. However, it should be noticed that the sample was insufficient for deciding the higher cut-off with enough power (19), due to the exclusion of patients at no/low nutritional risk according to the MEONF-II. The analysis for the higher cut-off, therefore, has to be considered as explorative and suggestive of the appropriate higher cut-off point. However, the fact that the identified higher cut-off coincides with that suggested based on clinical reasoning supports

Table 2. ROC-curve analysis including all cases identifying the optimal lower cut-off point (indicated with *) for the MEONF-II in comparison to the MNA

Criterion	Sensitivity (95% CI)	Specificity (95% CI)	Youden index
> =0	1.0 (0.96–1.00)	0.00 (0.00–0.04)	0.00
>0	0.80 (0.71–0.88)	0.65 (0.55–0.75)	0.45
>1	0.77 (0.67–0.85)	0.72 (0.61–0.81)	0.49
>2*	0.67 (0.57–0.77)	0.85 (0.76–0.91)	0.52
>3	0.54 (0.44–0.65)	0.90 (0.82–0.95)	0.44
>4	0.37 (0.27–0.48)	0.93 (0.86–0.98)	0.30
>5	0.27 (0.18–0.37)	0.97 (0.91–0.99)	0.24
>6	0.13 (0.07–0.22)	0.99 (0.94–1.00)	0.12
>7	0.03 (0.01–0.09)	1.0 (0.96–1.00)	0.03
>8	0.0 (0.00–0.04)	1.0 (0.96–1.00)	0.00

Youden index = sensitivity + specificity −1.
MEONF-II = Minimal Eating Observation and Nutrition Form – Version II; MNA = Mini Nutritional Assessment.

its usefulness. In addition, it should be remembered that the main purpose with screening is to identify people at risk and not to decide whether it is a low or high risk and that any case being at risk needs a more detailed assessment. From that perspective, the most important cut-off point is the lower one, which identifies any case at risk of UN irrespective of how severe the risk is.

The occurrence of moderate/high UN risk in this study, 41% according to MEONF-II, is somewhat higher than what has been found in other studies. For instance, in one study ($n = 2170$) the point prevalence of moderate/high UN risk was 34, 26, and 22% in large-, middle-, and small-sized hospitals, respectively (26). One explanation for this could be that the mean age was lower (66–70 years) in that study compared to the sample studied here

Table 3. ROC-curve analysis identifying the higher cut-off (indicated with *) for MEONF-II, including only patients at moderate/high risk for undernutrition according to the MEONF-II, in comparison to MNA (well nourished/at risk for undernutrition vs. undernutrition) ($n = 76$)

Criterion	Sensitivity (95% CI)	Specificity (95% CI)	Youden index
> =3	1.00 (0.86–1.0)	0.00 (0.0–0.07)	0.00
>3	0.83 (0.63–0.95)	0.25 (0.14–0.39)	0.08
>4*	0.75 (0.53–0.90)	0.58 (0.43–0.71)	0.33
>5	0.58 (0.37–0.78)	0.73 (0.59–0.84)	0.31
>6	0.37 (0.19–0.59)	0.92 (0.81–0.98)	0.29
>7	0.12 (0.03–0.32)	1.00 (0.93–1.00)	0.12
>8	0.00 (0.0–0.14)	1.00 (0.93–1.00)	0.00

Youden index = sensitivity + specificity −1.
MEONF-II = Minimal Eating Observation and Nutrition Form – Version II; MNA = Mini Nutritional Assessment.

Table 4. Diagnostic performance of the MEONF-II lower cut-off and higher cut-off compared to the MNA

	Number of patients A	B	C	D	SENS[a] (95% CI)	SPEC[b] (95% CI)	PPV[c] (95% CI)	NPV[d] (95% CI)	Accuracy[e]
MEONF-II lower cut-off (>2 points) in relation to MNA (any risk), $n = 184$	62	14	30	78	0.67 (0.57–0.77)	0.85 (0.76–0.91)	0.82 (0.71–0.89)	0.72 (0.63–0.80)	0.76
MEONF-II higher cut-off (>4 points) in relation to MNA, $n = 76$[f]	18	22	6	30	0.75 (0.53–0.90)	0.58 (0.43–0.71)	0.45 (0.29–0.62)	0.83 (0.67–0.94)	0.63

Screening (MEONF-II)	MNA Positive	MNA Negative
Positive	A	B
Negative	C	D

[a]SENSitivity = A/(A + C).
[b]SPECificity = D/(B + D).
[c]Positive Predictive Value (PPV) = A/(A + B).
[d]Negative Predictive Value (NPV) = D/(C + D).
[e]Accuracy = A + D/(A + B + C + D).
[f]After exclusion of patients with no/low risk for undernutrition according to the MEONF-II.
MNA = Mini Nutritional Assessment; CI = Confidence Interval; MEONF-II = Minimal Eating Observation and Nutrition Form – version II; UN = undernutrition.

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(77 years). In another large study, including 12 countries, the prevalence of UN among 1,384 older hospital inpatients (mean age: men, 81.2 years; women, 82.9 years) was 38.7% according to the MNA, while another 47.3% were at risk for undernutrition and 14.0% were well-nourished (27). The prevalence found in that study is higher than found here (50% at risk or already undernourished according to the MNA). Thus, through this perspective, the sample studied here appears representative of, at least, older in-hospital patients in general but perhaps not the oldest-old.

The feasibility of using MNA as a 'gold standard' can be discussed even though it is commonly used as the comparator for nutritional assessment (5–8, 14, 15). The full MNA as used in this study represents a detailed and in-depth assessment that agrees strongly with extensive investigations of nutritional status (2, 3). A strength with the MNA is that it detects risk of malnutrition at an early stage, i.e. when albumin levels and BMI are still normal (12), which increases the possibility to take preventive actions. A potential disadvantage with the MNA is that it was developed for people 65 years or older (12). However, a previous study found no relevant differences in sensitivity and specificity of the MEONF-II in comparison to the MNA when including the full sample or when excluding the younger subsample (8).

An advantage of using the MEONF-II compared to other screening tools is that it also identifies actual problems for which immediate actions can be taken. Eating difficulties in the screening is especially important as such difficulties are predictors of the need for nutritional intervention as well as weight loss, length of hospital stay, and need for higher level of care after discharge from hospital (9, 10, 28, 29). The MEONF-II may thus facilitate the identification of people at risk for undernutrition while simultaneously identifying potential underpinning problems and subsequent interventions. For example, if low energy levels/poor appetite is identified, the provision of protein- and energy-enriched food and food supplements might be important and in cases of swallowing/mouth problems, adaptation of food consistency is an important intervention (10). By identifying eating difficulties, nurses can also initiate consultation with other professionals, depending on the type of problems, such as physiotherapists (adjustment of sitting position), occupational therapists (adapting cutlery), dietician (increasing energy intake/appetite), speech therapists (improve swallowing), or dental hygienist (if problems with chewing).

Conclusion

The cut-off scores based on clinical reasoning were confirmed statistically and validated the current version of the MEONF-II. Together with previous studies of the MEONF-II, these observations support the usefulness of the MEONF-II as an interpretable and user friendly tool for identifying people at risk for undernutrition while also providing a means for targeted interventions.

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Conflict of interest and funding

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