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Population-specific Mini Nutritional Assessment effectively predicts the nutritional state and follow-up mortality of institutionalized elderly Taiwanese regardless of cognitive status

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The study was conducted to determine the effectiveness of a modified Mini Nutritional Assessment (MNA) for assessing the nutritional status and predicting follow-up mortality of institutionalized elderly Taiwanese. The study was conducted in a large long-term care centre in central Taiwan. Trained interviewers assisted by the caregivers elicited sociodemographic data, healthcare and disease history, and answers to the MNA screen from each subject. One researcher performed all subjects' anthropometric measurements. Plasma albumin and cholesterol concentrations were determined. Results showed that the MNA without BMI, modified according to population-specific mid-arm circumference and calf circumference cut-points, effectively predicted the nutritional risk status of the elderly regardless of cognitive status. Substituting caregiver's assessments for self-viewed nutrition and health status (questions O and P of MNA) improved the predicting power of the tool in cognition-normal subjects. Results showed that 21·9 % of the elderly were malnourished, 59·2 % were at risk of malnutrition and 18·9 % were normal according to self-assessment whereas 14·2 % were malnourished, 59·2 % were at risk of malnutrition, and 26·6 % were normal according to caregiver's evaluation. The tool was also effective in predicting 12- and 6-month follow-up mortality in cognition-normal and cognition-impaired elderly, respectively. Results indicate that a population-specific MNA can effectively predict the nutritional status and 6-month follow-up mortality of elderly Taiwanese regardless of cognitive condition. Easier and wider application of the tool will enable early detection of emerging nutritional problems and timely intervention to prevent the development of severe malnutrition in the elderly.

Nutritional assessment: Nutritional status: Elderly: Mortality

Malnutrition is common among frail elderly whether living at home or in care institutions. Poor nutrition can weaken one's immune competency and increase disease risk and mortality. Nutritional intervention can be effective in alleviating malnutrition, minimizing disease risk, reducing hospital stay and improving the quality of life of the elderly. To identify the malnourished elderly or individuals at risk of malnutrition, an appropriate nutritional assessment tool is often required. The Mini Nutritional Assessment (MNA) is one of the most widely used tools for such a purpose. The MNA is a simple, easy to use and non-invasive tool. The tool was developed using data generated from geriatric patients in the United States and Europe and validated with clinical data of Caucasian populations[1–3]. The tool has been shown to be useful for grading nutritional status and for predicting long-term mortality for geriatric patients entering hospitals and for elderly living at home or in care institutions[4–10]. The MNA has been used in hundreds of studies and translated into more than twenty languages[3]. However, in its original form, the tool has significant limitations in its application to non-Western, non-Caucasian groups of elderly. It has been pointed out that for it to be a truly useful screening tool for the non-Caucasian populations, the tool needs to be modified using as much country- or region-specific data and criteria as possible on the form[11]. In a previous study, the criteria for anthropometric parameters including BMI, mid-arm circumference (MAC), and calf circumference (CC), have been modified according to population-specific values based on data derived from a population-representative sample in Taiwan[12]. Modifications were also made to the diet-related questions in the MNA screen to reflect the dietary habit of the Taiwanese. The current study was conducted to evaluate the functionality of the modified MNA in elderly of varying cognitive status in a large long-term care institution in Taiwan. The study also compared caregiver's answers on two self-view questions (O and P for nutritional and health conditions, respectively) to patients' self-evaluations. Caregiver's assessment, if proven to be acceptable for replacing self-assessment, will greatly enhance the usefulness of the tool, resulting in improvement in patient care and enhancement of job efficiency of the primary care professionals.

Abbreviations: CC, calf circumference; MAC, mid-arm circumference; MNA, Mini Nutritional Assessment; WC, waist circumference.

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Subjects and methods

The study was conducted in a large long-term care institution in Central Taiwan. Of the 351 residents, 308 (125 men and 183 women) qualified and participated in the study. Residents, 65 years or older with a minimum of 3-month of residency at the centre, were allowed to participate. Residents who had acute infections or illness, or were hospitalized during the study period were excluded from the study. A trained interviewer administered an on-site, face-to-face, interview to elicit participants' sociodemographic status, health condition, long-term care and hospitalization-related information, and the responses to the questions in the MNA screen[12]. For residents who had cognitive disorders, mental disabilities or communication difficulties, the caregivers were allowed to assist in answering the questions. For comparison purposes, residents who were cognitively competent, the answers to questions O and P for 'self-viewed' health and nutrition conditions were evaluated in two ways, by patient's view and by the caregiver's evaluations, respectively. All participants' MAC, CC, and waist circumference (WC), were measured. Additional information on participants' disease history and hospital stay was obtained from records maintained at the institution. Of the 308 participants 169 were cognitively competent to provide answers to questions O and P and were referred to as the 'cognition-competent' or 'cognition-normal' subjects. The remaining 139 elderly could not provide meaningful answers to these two questions and were considered 'cognition-impaired'.

Measurements of MAC, CC and WC were carried out with a flexible but non-stretchable measuring tape and were recorded to 0·1 cm. All measurements followed standard procedures but with subjects in supine positions[13]. In order to avoid inter-rater variations (such as variation in measuring position or tightness of the tape) in anthropometric measurements, one technician performed all measurements. A blood specimen of approximately 10 ml was taken from each participant under an over-night fasting condition on a separate day but within one week of the interview for the determination of plasma albumin and cholesterol concentrations. All biochemical assays were performed with standardized procedures by a government-approved clinical laboratory (Sing Chung San Clinical Laboratory, Chang-Hua, Taiwan).

In this study, the nutritional risk status of each participant was evaluated with a modified version of the MNA, using population-specific MAC and CC cut-points instead of values specified in the original MNA[12]. Question F (BMI) was not included because weight and height were not measured. The weighted score of MAC was adjusted from one to two points and CC from one to three points to cover the weighted score attributed by BMI in the original scale in consideration of the meaning of these indicators and in order to maintain the same total MNA score (thirty points). The detail of the assigned scores is shown in Table 1. Graded increments of one point per cm above the minimum cut values were applied to the modified MAC and CC scales[14]. The minimum cut-values for the modified MAC and CC scales are the fifth percentile values of the population-representative MAC and CC distributions of the elderly Taiwanese[12]. For cognition-normal subjects, the total MNA score of each participant was calculated in two ways, 'self-assessed' and 'caregiver-assessed'. All other questions were the same for both methods. For cognition-impaired subjects, all questions were caregiver-assessed. The Institutional Review Board of Asia University approved the study protocol. Subject's confidentiality was maintained throughout the study.

Results were statistically analysed with Statistical Package for the Social Sciences Base 10.0 Application Guide, 1999 (SPSS Inc. Chicago, IL, USA). The first and second 6-month follow-up survival or mortality were statistically analysed. Pearson's correlation analyses were performed to determine the correlation of the total MNA scores with each of the anthropometric values, serum albumin, cholesterol, hospital length-of-stay and mode of feeding. To avoid the condition that the independent variable being tested is a component of the dependent variable, the MNA was devoid of the variable when the respective correlation was analysed. Cox regression was performed to examine the association of nutritional status, cognitive function and assessment method with the time to death from the time of baseline nutritional assessment. A 5 % probability

Table 1. Anthropometric scales as specified in the original Mini Nutritional Assessment (MNA) or the modified scales for elderly Taiwanese men and women

	Original MNA		Modified MNA		
			Cut-point*		
Question in MNA scale	Cut-point	Score	Men	Women	Score
F. BMI (kg/m^2)	<19	0	(not used)		
	19–20	1			
	21–23	2			
	≥23	3			
O. Mid-arm circumference (cm)	<21	0	<22·5	21	0
	21–22	0·5	22·5–23·5	21–22	1
	≥22	1	≥23·5	22	2
P. Calf circumference (cm)	<31	0	<28	25	0
	≥31	1	28–28·9	25–25·9	1
			29–29·9	26–26·9	2
			≥30	27	3

* Revised according to population-specific mid-arm circumference and calf-circumference cut-points[12]. Scores adjusted to compensate for the deletion of BMI scores.

($P=0{\cdot}5$) was designated as the level of statistical significance but higher levels of significance were also indicated.

Results

The characteristics of subjects are shown in Table 2. Those who were cognition-impaired were about 2·5 years older and had more types of disabilities, lower serum albumin and total cholesterol levels and smaller CC and WC compared to the cognition-normal subjects (all $P<0{\cdot}05$). Women who were cognition-impaired also had smaller MAC, but this difference was not significant in men. Greater proportions of the cognition-impaired elderly were tube-fed or needing assistance in order to eat or were bed-ridden compared to the cognition-normal subjects (both $P<0{\cdot}001$).

The distributions of self-assessed and caregiver-assessed nutrition and health conditions (questions O and P) are shown in Table 3. Compared to assessments made by their caregivers, more elderly self-viewed their nutritional status as poor or were unsure of their nutritional status ($P<0{\cdot}01$). More elderly also assessed their health status as not as good as their peers or were unsure about their health status compared to assessments made by the caregivers ($P<0{\cdot}01$).

Results of nutritional status classified according to the two assessment methods and the first and the second 6-month follow-up mortality are shown in Table 4. Among the 169 elderly who were cognition-normal, 21·9 % were rated malnourished, 59·2 % at risk of malnutrition and 18·9 % normal according to self-assessment. The respective values were 14·2 %, 59·2 % and 26·6 % according to caregiver's evaluations. Of the 169 elderly, six died during the first 6-month follow-up period and thirty-three during the second 6-month period. The differences in the distribution of nutritional status among those who died between the two assessment methods were not significant. Of the 139 cognition-impaired elderly, forty-seven were rated malnourished, seventy-five at risk of malnutrition and seventeen normal. This distribution pattern is significantly different from that of the cognition-competent elderly. Seventeen of the 139 died during the first 6-month follow-up period and ten during the second 6-month period.

Table 5 shows the correlations of the total MNA scores with anthropometric, biochemical and health indicators, respectively. In order to avoid the condition that a variable being examined for the correlations is a component of the dependent variable, the total MNA score, care was taken to remove the contributing score of MAC and CC from the total MNA scores when testing the correlation of total MNA scores with MAC and CC, respectively. Pearson's correlation analysis showed that in cognitive-normal subjects, caregiver-assessed MNA status correlated better with all variables examined except age and serum cholesterol compared to correlations with self-assessed MNA scores. In cognition-impaired elderly, the correlation of the MNA

Table 2. Characteristics of cognition-normal (*n* 169) and cognition-impaired (*n* 139) elderly subjects

	Cognition-normal				Cognition-impaired				
Item	*n*	%	Mean	SD	*n*	%	Mean	SD	*P**
Gender									
Male	76	45·0			49	35·3			
Female	93	55·0			90	64·7			NS
Age (years)			79·6	7·6			82·2	7·9	<0·01
Years of education									
≤ 6	156	92·3			125	89·9			
7–9	10	5·9			6	4·3			
10–12	2	1·2			5	3·6			
> 12	1	0·6			3	2·2			NS
Mode of feeding									
Self-feeding	149	88·2			49	35·3			
Need help	17	10·1			31	22·3			
Tube-fed	3	1·8			59	42·4			<0·001
Mobility									
Bed-ridden	23	13·6			81	58·3			
Wheel-chair-bound	108	63·9			50	36·0			
Needing a walker	11	6·5			4	2·9			
Able to walk freely	27	16·0			4	2·9			<0·001
Number of disability†			1·8	1·0			3·1	1·0	<0·001
Mid-arm circumference (cm)									
Men			24·8	3·3			24·1	2·8	NS
Women			23·6	3·3			22·2	4·1	<0·01
Calf circumference (cm)									
Men			29·3	4·1			27·7	3·2	<0·05
Women			27·8	3·9			24·2	3·8	<0·001
Waist circumference (cm)									
Men			82·2	10·6			77·8	10·4	<0·05
Women			85·4	10·9			77·5	10·4	<0·001
Serum albumin (g/dl)			3·8	0·3			3·6	0·3	<0·001
Total cholesterol (mmol/l)			4·7	1·0			4·3	1·0	<0·001

* *P* values are on basis of χ^2 analysis for gender, education, mode of feeding and mobility. All others are on basis of *t* test.
† Including immobility, incontinence, delirium and swallowing difficulty.

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Table 3. 'Self assessed' health and nutritional status (Questions O and P), according to subjects' or caregivers' assessments

		Cognition-normal				Cognition-impaired	
		Self-assessed		Caregiver-assessed		Caregiver-assessed	
Question	Score	*n*	%	*n*	%	*n*	%
O. Nutritional status							
Poor	0	65	38·5	18	10·7	24	17·3
Not sure	1	59	34·9	39	23·1	30	21·6
No nutritional problem	2	45	26·6	112*	66·3	85†	61·2
P. Health status							
Not as good	0	53	31·4	15	8·9	40	28·8
Does not know	0·5	18	10·7	5	3·0	10	7·2
As good	1	50	29·6	89	52·7	67	48·2
Better	2	48	28·4	60*	35·5	22†	15·8

* The distribution of nutritional status is significantly different from that of the self-assessed ($P<0·01$).
† The distribution of nutritional status is significantly different from that of the cognition-normal elderly ($P<0·01$).

score with age, MAC and CC were stronger compared to cognition-normal elderly whereas the correlations of the MNA score with WC, albumin, total cholesterol, hospital length-of-stay and mode of feeding were weaker.

Fig. 1 shows the survival curves and the associations of nutritional status, cognitive function and assessment method of patients with the time to death from the time of nutritional assessment. Log-rank (Mantel-Cox) tests showed significant differences in 12-month survival between normal and at risk ($P<0·01$) and malnourished ($P<0·05$) groups in cognition-normal elderly assessed by the caregivers but not by self-assessment. Significant differences also existed in 6-month but not 12-month survival between the normal and at risk ($P<0·01$) and malnourished ($P<0·01$) groups in cognition-impaired elderly assessed by their caregivers.

Discussion

The MNA has been intended to provide the primary care health professionals with an efficient tool for identifying the elderly individuals malnourished or at risk of malnutrition. It was designed to assess nutritional status of frail elderly individuals having some functional impairment such as immobility, hearing, speech and cognitive disorders, and living alone or in nursing homes, or being hospitalized[6]. The tool assesses one's nutritional status in four dimensions: anthropometric measurements including weight changes and body muscle mass; global assessment including lifestyle, medication and mobility status; dietary assessment to indicate intake of fluid and important nutrients and feeding status; and subjective self-perception of health and nutrition status. Since elderly who have cognitive disorders or dementia will have impaired ability to answer the questions in the MNA, it has been suggested that in those individuals the health professional (the interviewer) must score the MNA with the caregiver or based on his/her own judgement of the conditions[6]. According to our experience, to the cognitively less competent elderly the two self-assessed questions are among the questions with which they often encounter the greatest difficulties. The frail or cognitively less competent elderly, especially those who have had little formal education, have difficulty in both comprehending and answering these two questions. Thus, a caregiver-assessed MNA, if effective, will greatly enhance the usefulness of the tool.

Table 4. First and second follow-up 6-month total mortality of cognition-normal and cognition-impaired elderly based on nutritional risk status classified according to the original or the modified MNA

	Nutritional risk status		
Item	Malnourished	At risk of malnutrition	Normal
Cognition normal, self-assessed (*n* 169)			
n in group/*n* total	37/169 (21·9 %)	100/169 (59·2 %)	32/169 (18·9 %)
n death/*n* in group			
First 6 months	2/37 (5·4 %)	3/100 (3·0 %)	1/32 (3·1 %)
Month 7–12	2/37 (5·4 %)	9/100 (9·0 %)	0/32 (0 %)
Cognition normal, caregiver-assessed (*n* 169)			
n in group/*n* total	24/169 (14·2 %)	100/169 (59·2 %)	45/169 (26·6 %)
n death/*n* in group			
First 6 months	1/24 (4·2 %)	5/100 (5·0 %)	0/45 (0 %)
Month 7–12	2/24 (8·3 %)	9/100 (9·0 %)	0/45 (0 %)
Cognition-impaired, caregiver-assessed (*n* 139)			
n in group/*n* total	47/139 (33·8 %)	75/139 (54·0 %)	17/139 (12·2 %)*
n death/*n* in group			
First 6 months	7/47 (14·9 %)	10/75 (13·3 %)	0/17 (0 %)
Month 7–12	3/47 (6·4 %)	4/75 (5·3 %)	3/17 (17·6 %)

* The distribution of nutrition status was significantly different ($P<0·05$) from that of the cognition-normal elderly on basis of χ^2 test.

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Table 5. Correlations of self-assessed and caregiver-assessed total Mini Nutritional Assessment (MNA) scores (revised scale) with anthropometric, albumin and health status in cognition-normal and cognition-impaired elderly

	Cognition-normal (*n* 169)				Cognition-impaired (*n* 139)	
	Self-assessed		Caregiver-assessed		Caregiver-assessed	
	r	*P*	*r*	*P*	*r*	*P*
Age	−0·190	0·013	−0·167	0·030	−0·228	0·007
Waist circumference	0·408	<0·0001	0·461	<0·0001	0·375	<0·0001
MAC*	0·244	0·001	0·355	<0·0001	0·485	<0·0001
CC*	0·255	0·001	0·364	<0·0001	0·395	<0·0001
Albumin	0·299	<0·0001	0·333	<0·0001	0·254	0·005
Total cholesterol	0·245	0·002	0·231	0·003	0·032	0·729
Hospital length-of-stay	−0·216	0·006	−0·265	0·001	−0·257	0·003
Mode of feeding†	0·300	0·169	0·324	<0·0001	0·191	0·025

MAC, mid-arm circumference; CC, calf circumference.
* In order to avoid the condition where the independent variable is a component of the dependent variable, the scores of MAC and CC were removed from total MNA scores when testing for its correlation with MAC and CC, respectively.
† Categorically whether self-fed, need assistance or tube-fed.

Results of the present study indicate that under the condition that everything else remains the same, the caregivers can provide a more effective 'self-evaluation' of patient's nutritional and health conditions (questions O and P) compared to patient's self-evaluations. This is evidenced by improved correlation of the total MNA score with each of the health indicators including the 'gold standard', serum albumin. Caregiver's assessment is also more effective in predicting follow-up mortality compared to patient-assessed MNA. The caregiver-assessed MNA predicted all seventeen deaths (six during the first 6-month and eleven during the second 6-month period) whereas the self-assessed MNA predicted sixteen of the seventeen cases during the same period. The caregiver-assessment is also effective in predicting both nutritional status and 6-month follow-up mortality in cognition-impaired elderly. Results of Cox regression analysis of the probability of survival of the elderly subjects further supports this finding. In cognition-normal patients, significant differences in the probability of survival between the nutritionally normal and at-risk and malnourished elderly were observed only by caregiver-assessment but not by self-assessment, whereas in cognition-impaired patients, significant differences in the probability of survival between the nutritionally normal and at-risk and malnourished were also observed when assessed by the caregivers. These results indicate that using the modified MNA screen the caregiver can effectively evaluate the nutritional risk status of the elderly, regardless of their cognitive status. Caregiver's professional knowledge and experience probably contribute to the improved predicting power of the MNA. In cognition-competent elderly the predicting power seems to last beyond one whole year whereas in cognition-impaired elderly, the predicting power weakens after the first 6 months. This is probably due to generally poorer health conditions of the cognition-impaired elderly.

The MNA has been shown to have significant predicting power on mortality in a Danish population[15] and in geriatric patients[16–20]. Individuals scored 24 points or better had significantly lower follow-up mortality compared with those who scored less. Depending on the condition of subjects, one-year follow-up mortality varied from <10 % to as high as 50 % among those who were classified malnourished (MNA score <17). The MNA has been used as a grading scale for providing nutritional intervention to frail elderly. Individuals who score <17 MNA points are considered to have protein-energy malnutrition and should receive immediate nutritional intervention otherwise their immune competency will be severely compromised whereas those scored 17 to 23·5 points are at risk of protein-energy malnutrition and should also be advised to correct potential nutritional deficiency before becoming malnourished[6].

There are three important features in this modified MNA screen for the Taiwanese elderly population: (a) It does not require BMI values, thus measurements of height and weight are not required. Measuring weight and height may not be always possible because of lack of special equipment; and the accuracy, especially of height, is not always assured. (b) It uses population-specific MAC and CC cut-points and thus can presumably produce more accurate results, and (c) the tool can be caregiver-assessed and thus can be applied to both cognition-normal and cognition-impaired individuals. Those features will undoubtedly improve both the utility and the accuracy of the tool. The modified tool should be a valuable tool for monitoring nutritional status of the frail elderly whether they are home-living or institutionalized. It will enable timely nutritional intervention to correct nutritional deficiencies or to prevent developing nutritional deficiencies in those high-risk individuals.

Although the current study was conducted in a relatively large long-term care centre with mixed types of residents in Taiwan, the application of this tool to assess the nutritional risk status of elderly with specific chronic health conditions such as stroke, dementia, renal disease or cancer requires further confirmation. The effectiveness of the tool in home-living elderly also requires confirmation. It is also important to ascertain whether information obtained from close family members can be as good as the caregivers in long-term care institutions.

Conclusion

The current study has demonstrated that using a modified MNA screen the nutritional status of the institutionalized frail elderly can be effectively assessed by the caregivers.

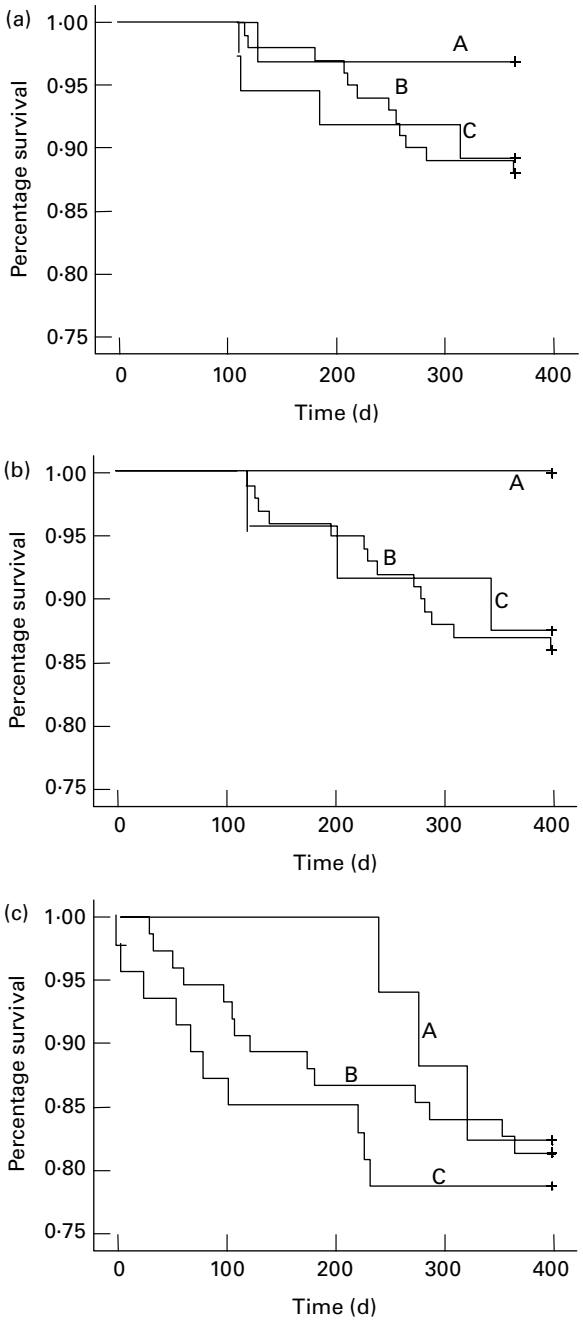

Fig. 1. Survival curves for subjects according to cognitive status ((a) and (b) cognition-normal; (c) cognition-impaired), assessment methods ((a) self-assessed; (b) and (c) caregiver-assessed) and Mini Nutritional Assessment status at baseline. Lines A, B and C represent normal, at risk of malnutrition and malnourished status, respectively. Log-rank (Mantel-Cox) tests showed significant differences in 12-month survival between normal and at risk ($P<0·01$) and malnourished ($P<0·05$) groups in (b) (cognition-normal, caregiver-assessed). Significant differences were also observed in 6-month survival between normal and at risk of malnutrition ($P<0·01$) and malnourished ($P<0·01$) groups in (c) (cognition-impaired, caregiver-assessed).

Caregivers' assessments are more effective in predicting nutritional risk status and the 6-month follow-up mortality in institutionalized cognition-normal elderly compared to patients' self-evaluations. Results of the present study also show that using caregiver's evaluation, the MNA is effective in predicting the nutritional risk status and 6-month follow-up mortality of the cognition-impaired elderly.

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