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Mini-Nutritional Assessment predicts functional decline of elderly Taiwanese: result of a population-representative sample

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Abstract

Nutrition is a key element in geriatric health and is important for functional ability. The present study examined the functional status-predictive ability of the Mini-Nutritional Assessment (MNA). We analysed the dataset of the 'Survey of Health and Living Status of the Elderly in Taiwan', a population-based study conducted by the Bureau of Health Promotion of Taiwan. Study subjects (≥65 years old) who completed both the 1999 and 2003 surveys were rated with the long form and short form of the MNA at baseline and with the Activities of Daily Living (ADL) and the Instrument Activities of Daily Living (IADL) scales 4 years later (end-point). The ability of the MNA to predict ADL or IADL dependency was evaluated with logistic regression models. The results showed that the elderly who were rated malnourished or at risk of malnutrition at baseline generally had significantly higher ADL or IADL scores 4 years later. Lower baseline MNA scores also predicted a greater risk of ADL or IADL dependency. These associations exist even among the elderly who were free of ADL or IADL dependency at baseline. The results clearly indicate that the MNA is able to predict ADL and IADL dependency (in addition to rating current nutritional status) of the elderly. The MNA, especially the short form, should be a valuable tool for identifying elderly at risk of functional decline and/or malnutrition in clinical practice or community programmes.

Key words: Mini-Nutritional Assessment: Physical functional status: Nutritional status: Elderly: Taiwan

Ageing is associated with physiological and functional declines and an increased risk of malnutrition[1,2]. Studies have shown that approximately 25–45 % of community-living elderly are malnourished or at risk of malnutrition[3,4], and up to 80 % of outpatient, hospitalised or nursing home-living elderly are either malnourished or at risk of malnutrition[4–7]. In older adults, nutritional status has been shown to be associated with functional dependency[1,4,5,7–13]. Malnourished elderly have increased frequency of hospitalisation, increased length of hospital stay, and increased risk of depression, cognition impairment, poor quality of life or mortality[4–7,11,14–17].

The Mini-Nutritional Assessment (MNA), a validated and widely used nutritional assessment/screening tool, has been shown to have good sensitivity, specificity and reliability, and is effective for evaluating the nutritional status of the older adults in various living settings[4,18,19]. The MNA consists of eighteen items covering four dimensions (anthropometry, dietary assessment, global assessment and self-evaluation)[20]. It has better sensitivity and validity in detecting emerging malnutrition[4,21] in older adults compared with other single-domain indicators such as BMI, weight loss, energy intake or serum albumin. The MNA has two forms, a long form (or full scale) and a short form. The short form consists only of the first six items of the long form and is intended for pre-screening those who are potentially at risk of malnutrition. Those who are rated 'at risk' of malnutrition are further assessed with the rest of the long form. Those who are not rated 'at risk' are presumed normal and not further evaluated. The short-form MNA (MNA-SF) generally predicts the long form well under most conditions[4,22].

The MNA is a multifunctional scale and has been found to have the ability to evaluate the risk of depression, cognition impairment, physical functional decline and mortality in addition to grading the nutritional status of older adults. Several studies have shown that the MNA score is associated with physical functional status[5,6,12], and some studies have found that it has a physical functional status-predictive

Abbreviations: ADL, Activities of Daily Living; IADL, Instrument Activities of Daily Living; MNA, Mini-Nutritional Assessment; MNA-LF, long-form Mini-Nutritional Assessment; MNA-SF, short-form Mini-Nutritional Assessment; SHLSET, Survey of Health and Living Status of the Elderly in Taiwan.

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ability[7,23,24]. However, most of these studies have been conducted in small samples of community-living[23], institutionalised[6] or hospitalised elderly[24]. To our knowledge, no observation has been made in a large population-based sample. Hence, the objective of the present study was to examine the functional status-predictive ability of the MNA in a large population-based, longitudinal study in Taiwan.

Methods

Data and subjects

The study analysed data of the 'Survey of Health and Living Status of the Elderly in Taiwan' (SHLSET), a population-based longitudinal cohort study conducted by the Bureau of Health Promotion of Taiwan. The goal of the survey was to gain an understanding of the role of socio-economic, environmental, lifestyle and health care variables on health, well-being and quality of life of older Taiwanese[25,26]. The SHLSET employed a three-stage national probability sampling process. Stage 1 was to stratify the Taiwanese population into 361 primary sampling units and, after excluding thirty lightly populated mountainous primary sampling units, randomly selected fifty-six primary sampling units for further sampling. Stage 2 involved proportional-to-size random selection of blocks from the selected primary sampling units and the final stage was to randomly select two eligible persons from each of the selected blocks. A total of 4412 men and women aged 60 years or older were drawn with this process and among them, 4049 completed the first interview (a 91·8% completion rate) in 1989. Subjects in the cohort were interviewed with a structured questionnaire for eliciting personal data every 3 or 4 years (in 1989, 1993, 1996, 1999, 2003 and 2007). The completion rates ranged from 79·1 to 91·8%. A second sample of 2462 subjects, 50–66 years old, was drawn from the population with the same procedure in 1996 to extend the cohort to include the young-old. The method and procedure was reviewed and approved by government-appointed representatives. All participants signed an informed consent and subject anonymity was preserved at all times. The detailed sampling process of the survey has been described previously[27].

The 1999 survey had a greater emphasis on diet and nutrition and included data for evaluating subjects' nutritional status and, thus, was chosen as baseline of this analysis. The 2003 survey served as end-point. The present study analysed data of respondents who were ≥65 years of age in 1999 and completed both the 1999 and 2003 surveys.

Measurements

We rated the nutritional status of each subject with the long form and short form of a population-specific version (Taiwan version-2) of the MNA, which adopted the Taiwanese-specific anthropometric cut-off points[20,27] and replaced item R (calf circumference) for item F (BMI)[27]. MNA-Taiwan version-2 has been shown to be better or at least equal to MNA-Taiwan version-1 (a normalised version by adopting population-specific anthropometric cut-off points but did not replace item R for F). Data for all items in the long-form MNA (MNA-LF), except items I (pressure sore/skin ulcers) and M (fluid intake), were available in the survey database. So, the MNA was based on fifteen items with a maximum score of 28 points, rather than seventeen items for 30 points. However, the total score was proportionately adjusted on the full-score basis. A final score of 16·5 or less suggests malnourishment; 17–23·5, at risk of malnutrition; and 24 or more, normal. All items in the MNA-SF were available in the questionnaire. The MNA-SF has a maximum score of 14; a score of ≤11 suggests at risk of malnutrition and a score ≥12 is normal[20].

Functional status was assessed using a self-reported questionnaire about ADL and IADL adapted from the 1984 National Health Interview Survey Supplement on Aging[28]. The following two scores were derived from each scale: one measured difficulty in carrying out the items and the other measured the degree of difficulty on performing the tasks. To assess ADL, participants were asked whether they had difficulty bathing, dressing, transferring, eating, walking or toileting independently. An item that one 'cannot do independently' is considered 'dependent' for that item. Participants also rated the level of difficulty for performing each of the six items on a scale from 0 to 3 (0, no difficulty; 1, some difficulty; 2, much difficulty; 3, cannot do). Individual scores were summed across each of the six items to yield a total score from 0 to 18, with higher scores reflecting a higher level of ADL difficulty[29]. To assess IADL, participants were asked whether they had difficulty shopping, handling finances, transporting, housekeeping, using the telephone or doing some heavy housework. As with ADL, two scores were derived from each person.

Table 1. Characteristics of the subjects at baseline (*n* 2190)*
(Number of subjects and percentages)

Parameters	*n*	%
Sex		
Men	1158	52·9
Women	1032	47·1
Age (years)†		
65–74	1390	63·5
75–84	721	32·9
≥ 85	79	3·6
Formal education (years)		
≤ 6	1701	77·7
7–12	364	16·6
≥ 13	125	5·7
Living arrangement		
Alone	218	9·9
With others	1972	90·1
Smoking		
Yes	549	25·1
Drinking (times/week)		
< 1	1595	72·8
≥ 1	595	27·2
Physical activity (times/week)		
≤ 2	874	39·9
≥ 3	1316	60·1

* Values are weighting-adjusted.
† Mean age of the group was 73·36 (SD 5·28) years.

Statistical analysis

Subjects' baseline characteristics, nutritional status, attrition and the distribution ADL and IADL status were computed with simple statistics. Binary logistic regression analysis was performed to determine the significance of the association of subjects' nutritional scores (both short form and long form) with future ADL and IADL dependency (no ADL or IADL dependency *v.* ≥1 dependency) under two conditions: (1) including all participants (*n* 2190) regardless of baseline ADL or IADL status and (2) excluding those who were functionally dependent (had ≥1 ADL or IADL dependency, respectively) at baseline. All regression models controlled for sex, age, years of formal education, whether living alone, health behaviours (smoking, drinking and physical activity) and whether one had hypertension, heart disease, diabetes, stroke or cancer. All statistical analyses were performed with the SPSS/Windows 15.0 (Statistical Package for the Social Sciences, Chicago, IL, USA) software package. All values were weighting-adjusted according to the study design. Statistical significance for all analyses was accepted at $\alpha = 0{\cdot}05$.

Results

Table 1 shows the characteristics of the subjects at baseline (1999). The study included slightly more men than women. More than half (64 %) were 65–74 years old; only 22 % had ≥7 years of formal education; about 10 % were living alone; a quarter were current smokers or drank alcohol; and 60 % had routine exercise (≥3 times/week). MNA scoring patterns of the subjects are shown in Appendix 1.

Table 2 shows the mortality rates and functional decline according to baseline nutritional status rated with the MNA and analysed under two conditions, including all subjects or only those who were ADL/IADL-independent. The follow-up 4-year mortality rates were significantly higher for those who were rated malnourished or at risk of malnutrition compared with those who were rated normal. When rated with the MNA-SF, greater proportions of elderly who were rated at risk of malnutrition had ADL/IADL dependency or decline 4 years later compared with those who were nutritionally normal regardless of the regression model. Similarly, greater proportions of those who were rated at risk of malnutrition

Table 2. Distribution of the Activities of Daily Living (ADL) and Instrument Activities of Daily Living (IADL) status of ≥65-year-old Taiwanese at end-point (2003) according to baseline (1999) nutritional status graded with the long-form (LF) and short-form (SF) Mini-Nutritional Assessment (MNA) (Taiwan version-2; T2)†

(Mean values, standard deviations, number of subjects and percentages)

		Rated with MNA-T2-LF						Rated with MNA-T2-SF			
		Malnourished		At risk		Normal		At risk		Normal	
Items	*n*	*n*	%	*n*	%	*n*	%	*n*	%	*n*	%
ADL and IADL status											
All subjects											
Group (total)	2190	21	0·96	225	10·3	1944	88·8	395	18·0	1795	82·0
Became ADL-dependent‡		3	14·3[a,b]	47	20·9[b]	144	7·4[a]	65	16·5	129	7·2***
ADL score											
Mean			2·41[a,b]		3·55[b]		1·22[a]		2·71		1·19***
SD			4·91		5·94		3·80		5·27		3·80
Became IADL-dependent‡		17	81·0[c]	127	56·4[b]	585	30·1[a]	197	49·9	532	29·6***
IADL score											
Mean			9·38[b]		7·49[b]		3·68[a]		6·44		3·62
SD			5·33		6·58		5·38		6·34		5·37***
New ADL dependency§											
Group (total)	2146	19	0·89	203	9·46	1924	89·7	367	17·1	1779	82·9
Became ADL-dependent‡		2	10·5[a,b]	28	13·8[b]	131	6·8[a]	42	11·4	119	6·7***
ADL score											
Mean			2·05[a,b]		2·33[b]		1·14[a]		1·97		1·11***
SD			4·18		4·65		3·68		4·36		3·66
New IADL dependency§											
Group (total)	1768	6	0·34	118	6·7	1644	93·0	239	13·5	1529	86·5
Became IADL-dependent‡		5	83·3[c]	45	38·1[b]	361	22·0[a]	82	34·3	328	21·5***
IADL score											
Mean			7·26[b]		4·66[b]		2·68[a]		4·24		2·60***
SD			6·36		5·47		4·55		5·41		4·49
Mortality/attrition data‖											
Total *n* at baseline	2948	91	3·09	385	13·1	2472	83·9	681	23·1	2267	76·9
Died during 1999–2003	661	70	76·9[c]	160	41·6[b]	431	17·4[a]	284	41·7	377	16·6***
Non-responders at end-point	97	0		0		97		2		95	
Survived at end-point	2190	21		225		1944		395		1795	

[a,b,c] Values within the same set with unlike superscript letters were significantly different from each other ($P<0{\cdot}05$; ANOVA and Games–Howell *post hoc* test, or χ^2 and *post hoc* tests).

*** Values were significantly different from the 'at risk' values on the basis of Student's *t* test or χ^2 test ($P<0{\cdot}001$).

† Values are weighting-adjusted.

‡ Defined as having ≥1 ADL or IADL dependency, respectively.

§ By excluding those who had ≥1 ADL or IADL dependencies, respectively, at baseline.

‖ An update from an earlier report[15].

had higher ADL/IADL scores (greater dependency). When rated with the long form, the results were generally similar to those when rated with the short form, except that the elderly who were malnourished did not have higher scores (or dependency) regardless of the regression model.

Table 3 shows the association of baseline nutritional scores rated with the MNA (long form and short form) with the risk of becoming ADL/IADL-dependent 4 years later, adjusted for demographic, socio-economic, lifestyle and health-related variables. Both MNA-LF and MNA-SF significantly predicted functional dependency 4 years later regardless of the conditions examined. The MNA (both forms) did not predict IADL decline (an increase of 3 or more IADL points) in a model including all subjects, but significantly predicted IADL decline in a model that excluded those who had IADL dependency at baseline. The MNA-LF also significantly predicted ADL decline whether the model included all subjects or excluded those who had ADL dependency at baseline. The ability of the MNA-SF to predict ADL decline was marginal.

Discussion

Predicting functional dependency and decline

Previously, we have observed that poor nutritional status (rated with the MNA-LF) is associated with an increased risk of follow-up mortality[15]. The present study has further shown that the MNA is able to predict the risk of physical functional dependency or decline (as indicated by ADL and IADL) in older Taiwanese. Numerous cross-sectional studies have observed a strong correlation between the nutritional status and functional status of the elderly in various living settings. Ruiz-López *et al.*[30] observed a correlation between the MNA score and the mobility of institutionalised elderly women rated by the Katz score; and Chevalier *et al.*[11] observed that malnourishment was correlated with poor physical performance (gait speed) in elderly patients undergoing ambulatory rehabilitation. Poor ADL and IADL status has been found to be correlated with poor nutritional status rated with the MNA in community-living[23], institutionalised[6,31] and hospitalised elderly[32].

In several studies involving hospitalised or institutionalised elderly, the MNA has also been observed to have a functional status-predictive ability[7,23,24,33]. Cereda *et al.*[33] have shown that the MNA is suitable for grading functional status of institutionalised elderly. Salvi *et al.*[24] have observed that the MNA-SF is a good and rapid tool for screening the risk of malnutrition in hospitalised, non-surgical older patients, and those who scored ≤11 with the MNA-SF had a higher risk of developing functional decline during hospitalisation. Zeyfang *et al.*[34] found that the MNA was able to distinguish healthy and independently living older adults with normal functional status from persons with slightly impaired functions. The present study is the first to observe the future functional status-predictive ability of the MNA in a large population-based sample.

The MNA scale encompasses a relatively large number (eighteen items for the long form and six variables for the short form) of items and the diversity of the items makes the tool multidimensional and multifunctional. The MNA-LF contains items that rate mobility (item C), cognitive status (E) and the ability to live independently (G), self-feed (N), use instrument (Q) and move around (R). In the short-form (Taiwan version-2) version, three (C, E and R) of the six items in the scale evaluate functional ability. These properties

Table 3. Logistic regression models showing the ability of baseline Mini-Nutritional Assessment (MNA) scores in predicting Activities of Daily Living (ADL) and Instrument Activities of Daily Living (IADL) dependency or functional decline 4 years later*
(Odds ratios and 95 % confidence intervals)

	ADL				IADL			
MNA version	*n*	OR	95 % CI	*P*	*n*	OR	95 % CI	*P*
Predicting functional dependency†								
All subjects‡								
Long-form MNA	2147	1·08	1·02, 1·14	0·006	2147	1·10	1·05, 1·15	<0·001
Short-form MNA	2147	1·11	1·02, 1·21	0·018	2147	1·13	1·07, 1·21	<0·001
Excluding dependent ones§								
Long-form MNA	2100	1·08	1·02, 1·15	0·007	1738	1·14	1·09, 1·20	<0·001
Short-form MNA	2100	1·11	1·01, 1·21	0·024	1738	1·20	1·11, 1·29	<0·001
Predicting functional decline‖								
All subjects‡								
Long-form MNA	2147	1·06	1·01, 1·11	0·016	2147	1·02	0·98, 1·06	0·300
Short-form MNA	2147	1·08	1·00, 1·16	0·053	2147	1·02	0·96, 1·08	0·490
Excluding dependent ones¶								
Long-form MNA	2100	1·07	1·02, 1·13	0·009	1738	1·13	1·08, 1·19	<0·001
Short-form MNA	2100	1·08	1·00, 1·17	0·046	1738	1·20	1·12, 1·29	<0·001

* Values are weighting-adjusted. All models controlled for sex, age, education, alcohol drinking, smoking, physical activity, hypertension, diabetes, heart disease, stroke and cancer status at baseline.
† Defined as having ≥1 ADL or IADL dependencies, respectively.
‡ Including all subjects regardless of functional status at baseline (1999). The model also controlled for baseline ADL and IADL status.
§ Excluding subjects who had ≥1 ADL or IADL dependencies, respectively.
‖ Defined as an increase in ADL or IADL score ≥3 points over baseline.
¶ Excluding those who had ≥1 ADL or IADL dependencies, respectively, at baseline.

contribute to its functional activity-predictive ability and therefore, it can also reflect functional decline.

The MNA seems to predict IADL decline better than ADL decline, perhaps it is because IADL decline generally occurs earlier than ADL decline. The results also suggest that the MNA is a predictor of early functional decline.

The ability of the MNA to predict functional decline is also reflected in ADL and IADL scores. In general, greater proportions of the elderly who were malnourished or at risk of malnutrition at baseline became dependent 4 years later and had significantly higher ADL and IADL scores (poorer status) compared with those who were normal nutritionally. However, it is of interest to note that among those who survived, those who were rated malnourished at baseline did not have higher ADL or IADL scores than those who were rated at risk of malnutrition 4 years later. It is possible that many of those who survived were those who had only temporary illness (the false positives). Their nutritional and functional status would be improved once the condition was treated or corrected.

Short form v. long form in predicting functional decline

The MNA-SF was developed from the MNA-LF as a more time-efficient, nutrition-screening scale. It generally predicts the long form well in rating the risk of malnutrition[22]. We have also reported that the MNA-LF is quite effective in predicting follow-up mortality[15]. The present study has further shown that the short form performed quite favourably compared with the long form in predicting functional decline of the elderly. The short form consists of only six items, one-third of the number of items for the long form, and takes much less time to complete the rating process, especially the Taiwan version-2 (without BMI). Because the short form is more time efficient and easier to execute, it is more likely to be accepted as a routine screening tool in clinical practice and in community geriatric health promotion activities.

Strengths and limitations

The major strength of the present study is that the dataset is from a relatively large population-based longitudinal study, which enables analysing the ability of the MNA to predict functional decline. Also, the results derived from the present study should have good generalisability, applicable to all Chinese populations having similar lifestyle and anthropometric characteristics as the study population. However, there are also limitations. (1) Data are self-reports. Self-reports generally have acceptable quality but error or inaccuracies are inevitable. (2) The number of subjects with dementia, cognitive impairment or mental disability increases with ageing, which may adversely affect the completion rate and the quality of data. (3) Data on pressure sore and fluid intake (two MNA items) are not available and thus may cause a slight underrating of the risk of malnutrition by the MNA-LF. (4) Results could have been further supported with biomarkers or medical reports. However, no such data are available in the dataset.

Conclusion

Results of the present study suggest that the MNA (both short form and long form), a simple malnutrition screening tool, is also able to predict the risk of functional decline of the elderly. The MNA appears to be a valuable tool for routine screening of the elderly at risk of malnutrition and functional decline, two conditions that occur more frequently during advanced ageing. These two conditions can often have an impact on each other. Routine screening with the MNA might be an effective and efficient way of detecting emerging malnutrition and early signs of functional decline in the elderly.

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Appendix 1

Mini-Nutritional Assessment (MNA)-Taiwan version-2 (T2) scoring patterns by elderly Taiwanese (*n* 2190)*

(Number of subjects and percentages)

Item and conditions (item score)	Scoring	*n*	%
Screening (short form)			
A. Declined food intake over the past 3 months (2)			
Severe loss of appetite	0	186	8·5
Moderate loss of appetite	1	4	0·2
No loss of appetite	2	2000	91·3
B. Weight loss during last months (3)			
Lost ≥3 kg body weight	0	275	12·6
Does not know	1	13	0·6
No	3	1902	86·8
C. Mobility (2)			
Bed- or chair-bound	0	20	0·9
Able to get out of bed but does not go out	1	82	3·7
Can get out of bed and goes out	2	2088	95·3
D. Suffered psychological stress over the past 3 months (2)			
Yes	0	210	9·6
No	2	1980	90·4
E. Neuropsychological problems (2)			
Severe dementia or depression	0	20	0·9
Mild dementia	1	108	4·9
No psychological problems	2	2062	94·2
R. Calf circumference (cm) (male/female) (3)†			
< 28/< 25	0	31	1·4
28–29/25–26	1	42	1·9
29–30/26–27	2	47	2·1
≥ 30/≥ 27	3	2070	94·5
Assessment			
G. Lives independently (1)			
No	0	21	1·0
Yes	1	2169	99·0
H. Taking more than three prescribed drugs per d (1)			
Yes	0	87	4·0
No	1	2103	96·0
I. Pressure sore (data not available in the database)			
J. Eat full meals per d (2)			
1	0	1	0·1
2	1	76	3·5
> 3	2	2113	96·4
K. Consumption of protein-rich foods (1)			
0 or 1 'yes'	0	283	13·3
2 'yes'	0·5	977	44·2
3 'yes'	1	930	42·5
L. Fruit and vegetable intake (≥2 servings/d) (1)			
No	0	152	6·9
Yes	1	2038	93·1
M. Fluid intake (data not available in the database)			
N. Mode of feeding (2)			
Unable to eat without assistance	0	9	0·4
Self-fed with some difficulty	1	37	1·7
Self-fed without difficulty	2	2143	97·9
O. Self-view of nutritional status (2)			
Malnourished	0	156	7·1
Uncertain of status	1	230	10·5
No nutritional problem	2	1804	82·4
P. Self-rated health status compared with peers (2)			
Not as good	0	934	42·6
Uncertain or unknown	0·5	0	0
As good	1	1154	52·7
Better	2	102	4·7
Q. Mid-arm circumference (cm) (male/female) (2)†			
< 22·5/< 21	0	55	2·5
22·5–23·5/21–22	1	54	2·5
≥ 23·5/≥ 22	2	2081	95·0

* Values are weighting-adjusted.

† In MNA-T2, item R (calf circumference) replaces item F (BMI) in the original MNA and the total score of item Q (mid-arm circumference) is increased from 1 to 2 points, maintaining the same maximum score, 30 points.