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Validation of Nutritional Screening Tools Against Anthropometric and Functional Assessments Among Elderly People in Selangor

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ABSTRACT

This cross sectional study was conducted to determine the validity of three screening tools, Mini Nutritional Assessment Short Form (MNA-SF), Malnutrition Risk Screening Tool for Community (MRST-C) and Malnutrition Risk Screening Tool for Hospital (MRST-H) among elderly people at health clinics. The screening tools were validated against anthropometric and functional assessments. The anthropometric assessments that were carried out included body weight, height, arm span, body mass index (BMI), calf circumference (CC) and mid upper arm circumference (MUAC). A set of questionnaire on manual dexterity, muscular strength, instrumental activities daily living (IADL) and cognitive status was used to assess functional abilities. A total of 156 subjects were recruited from rural (38 subjects) and urban (118 subjects) health clinics at Sabak Bernam and Cheras respectively. Subjects' age ranged from 60 to 83 years old, with 44.2% were men and 55.8% women. The prevalence of muscle wasting among the subjects assessed from MUAC and CC were both 7.0%. MNA-SF had the highest correlation with BMI ($r = 0.497$, $p<0.001$), followed by MUAC ($r = 0.398$, $p<0.001$), CC ($r = 0.473$, $p<0.001$), cognitive assessment ($r = 0.229$, $p<0.001$) and handgrip strength ($r = 0.209$, $p<0.001$). Whilst MRST-C had the highest correlation with IADL score ($r = -0.320$, $p<0.001$) and MRST-H had the highest correlation with the lock and key test ($r = -0.325$, $p<0.01$). Sensitivity was the highest for MNA-SF (93.2%), followed by MRST-H (52.5%) and MRST-C (25.8%). Specificity was the highest for MRST-H (97.3%), followed by MRST-C (90.8%) and MNA-SF (79.4%). Positive predictive value (PPV) for MRST-H, MNA-SF and MRST-C was 55.5%, 18.2% and 14.1%, respectively. In conclusion, among the screening tools being validated, MNA-SF is considered the most appropriate tool to be used in health clinics for identification of elderly individuals who are at high risk of malnutrition.

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INTRODUCTION

Mortality rates have declined in virtually all countries due to progress in preventing infectious diseases and improving hygiene, sanitation and overall social development and living standards. As a result, the average life expectancy throughout the world is projected to reach 72 years in 2020 (Fahey *et al.*, 2003). This aging population phenomenon exists worldwide, both in developing and developed countries (Nourhashemi *et al.*, 2001; WHO 2002). In Malaysia, based on the year 2005 statistics, it is estimated that the percentage of elderly people age ≥ 65 was 4.6% compared to 3.9% in 2000. It is estimated that by the year 2050, the proportion will be increased by four-fold to 21% (7.9 million people) (Department of Statistics, 2005).

A few studies have shown that elderly people are at high risk of malnutrition (Gambert & Kassur, 1994; Jensen *et al.*, 2001). In Malaysia, several studies among older people in the community have shown that malnutrition still exists among this group of population. The prevalence varies from more than 2% (Sumaiyah, Muhammad Tauffik & Samiah Yasmin, 2003; Zaitun *et al.*, 2004) to almost 38% (Suzana, Dixon & Earland, 1999; Sherina *et al.*, 2004; Tan, 2006).

A healthy diet is an important factor to ensure optimum health and functional capability and has a major influence towards physical and functional demands of the well being of the elderly (Pirlich & Lochs, 2001). Nutritional problems often go unrecognised and untreated (Reilly *et al.*, 1995). It is therefore important to have screening methods that are able to identify those who are malnourished and those who are at risk of developing malnutrition. Nutritional screening tools can rapidly identify individuals who are at risk of malnutrition for the purpose of further nutritional assessment and intervention (Green & Watson, 2005). Specific nutritional screening tools involve estimation of food intake and anthropometric assessment with several biochemical indicators that are influenced by nutritional status (Omran & Morley, 2000). However, some of the nutritional assessment tools, for example anthropometry, dietary intake and biochemical tests may not be appropriate to detect elderly who are at risk of malnutrition. This is because the methods are expensive, time consuming and require a trained personnel to conduct the assessments (Mohs, 1994).

There has been a lot of work done to develop nutritional screening tools that are simple, rapid, cheap, effective and comprehensive for elderly people. The value of a screening tool depends on its sensitivity, specificity, predictive value and also acceptability to both the targeted subjects and healthcare workers (Elia, 2003). The tools should also consider current weight status (e.g. underweight or obesity), as well as past and likely future changes in weight, both of which are linked to food intake or appetite and disease severity (Elia, Zellipour & Stratton, 2005).

Among the different kinds of screening tools that have been used include Nutrition Screening Index (NSI) (Dwyer, 1994; Grinder & Costello, 1996), Malnutrition Universal Screening Tool (MUST) (Elia, 2003), Malnutrition Risk Scale (SCALES) (Morley, 1989) and Mini Nutritional Assessment Short Form (MNA-SF) (Guigoz, Vellas, & Garry 1994 & 1996; Vellas *et al.*, 2000; Rubenstein *et al.*, 2001). They have been used in community population to screen for elderly who are at risk of malnutrition.

The Mini Nutritional Assessment Short Form (MNA-SF) consists of 6 of the 18 items of the full MNA (Rubenstein *et al.*, 2001). MNA-SF has been developed in Switzerland to identify elderly who are at high risk of malnutrition either in the hospital or the community. Although the MNA was developed specifically for frail older people, it has been validated in a healthy older population and has been widely used and validated in many European countries. It was reported that this screening tool has sensitivity, specificity and positive predictive value (PPV) of 96%, 98% and 97% respectively in identifying those elderly who are at risk of malnutrition (Guigoz, Vellas & Garry 1994 & 1996; Vellas *et al*., 2000; Rubenstein *et al*., 2001). It has also been evaluated in a group of Japanese frail elderly and found to have a sensitivity and specificity of 85.9% and 84% in identifying under-nutrition respectively (Kuzuya *et al*., 2005).

In Malaysia, a Malnutrition Risk Screening Tool for Community (MRST-C) specifically for the community elderly has been developed based on local studies (Suzana, Dixon & Earland, 1999). The MRST-C has been validated among rural elderly Malays and Chinese and also institutionalised Chinese elderly at several places in Malaysia, including Kedah, Kelantan and Negeri Sembilan (Suzana *et al*., 2007). However, its usefulness in detecting malnourished individuals in an urban setting or health clinics has not been tested. Another screening tool, Malnutrition Risk Screening Tool for Hospital (MRST-H) recently has been developed locally and validated to identify elderly hospitalised patients who are at risk of malnutrition. It is a screening tool that includes physical, clinical and anthropometric examinations (Sakinah, 2006). As this tool has been developed and validated based on hospitalised elderly, it also needs to be validated in a community setting.

In Malaysia, government health clinics provide inexpensive access to medical services for most of the elderly. Currently, functional assessments have been included as part of the medical assessment for elderly patients who attend selected health clinics which conduct the "Elderly Health Program". Besides measurements of body weight and height, there are no nutritional risk assessments carried out to assess the nutritional status of the elderly. As adequate nutrition is essential towards the well being of the elderly, it is necessary to have an assessment method that could identify elderly individuals who are prone to malnutrition. Screening tools provide an economical and rapid method of identifying those elderly who are at high risk of malnutrition. However, the screening tools used have to be validated to assess their appropriateness on the intended targeted population. This cross-sectional study was conducted to determine the validity of three screening tools, namely the Mini Nutritional Assessment Short Form (MNA-SF), Malnutrition Risk Screening Tool for Community (MRST-C) and Malnutrition Risk Screening Tool for Hospital (MRST-H) among elderly people who attended the health clinics in an urban and a rural area (Appendix). The screening tools were validated against anthropometric and functional assessments, as shown in Figure 1.

METHOD

This cross sectional study was conducted among elderly people who visited the outpatient health clinics of Klinik Kesihatan Cheras Baru (an urban area), Klinik Kesihatan Bagan Terap at Sabak Bernam (a rural area) and at the Rumah Sejahtera Day Care Centre, Cheras (an urban area), which is a day care centre for non-institutionalised elderly people. Subjects recruited in this study included those who were aged 60 years and above, were free from physical deformation that could have affected the anthropometric assessments, were able to communicate and had given consent. The subjects were recruited from July to September 2006.

Subjects were asked to provide information on socio-demographic and personal profile such as marital status, source of income, level of education and job status, through an interview. All subjects were

"New Tests" for nutritional screening	"Established Tests" of nutritional and functional status
MNA-SF	Anthropometry: BMI CC MUAC Arm span
MRST-C	Functional status: IADL Quadriceps muscle Lock and key
MRSC-H	Cognitive assessment Handgrip strength

Figure 1. Tests used in the study

screened for malnutrition risk using three screening tools, namely MNA-SF, MRST-C and MRST-H (Appendix). Then they were assessed for anthropometric and functional status, as reference standards or established tests for nutritional status assessments. The anthropometric assessments that were carried out included body weight and height (Fidanza & Keller, 1991), arm span (Kwok & Whitelaw, 1991), calf circumference (CC) (Chumlea, Guo & Vellas, 1994) and mid upper arm circumference (MUAC) (Ferro-Luzzi & James, 1996). Body mass index (BMI) was calculated from measured height and estimated height from arm span for those with kyphosis (Suzana & Ng, 2003). MUAC and CC are parameters used for measurement of muscle mass and subcutaneous adipose tissue (Woods & Moshang, 2005) and a low MUAC among the elderly has been shown to increase risk of mortality (Tajima *et al*., 2004). A MUAC value of less than 23.0 cm for men and 22.0 cm for women indicates loss of peripheral muscle mass (Ferro-Luzzi & James, 1996). As for CC, a value of less than 30.1 cm for men and 27.3 cm for women will indicate muscle loss, especially in the lower limb (Sakinah, 2006).

Functional assessment involved a self reported functional disability using Instrumental Activity Daily Living (IADL) (Fillenbaum *et al*., 1988) and cognitive assessment based on the Elderly Cognitive Assessment Questionnaire (ECAQ) (Kua & Ko, 1992). Manual dexterity was also assessed using Lock and Key test (Manandhar, 1995). Climbing stairs to assess quadriceps muscle strength (Bennet, 1999) and handgrip strength using Hand Dynanometer (Hillman *et al*., 2005) were also conducted as functional assessment. The whole process of data collection took about 40 minutes to complete.

Data analysis was analysed using "Statistical Package for the Social Sciences 12.0" (SPSS version 12.0). Unpaired t test was used to differentiate between sex, age group and locations (urban and rural) for numerical data. Chi squared test was used to assess the differences between sex, for factors on demography and psychosocial factors, and functional status that are categorical data. Correlation test was used to assess the nutritional screening tools scores (MRST-C, MRST-H and MNA-SF) with other nutritional status indicators. Mann Whitney test was used to test for differences between sex, age group and classification of screening tools for ordinal data such as IADL score. The statistical analysis was conducted at a significant level of 0.05. In addition, analysis on sensitivity, specificity and positive predictive value (PPV) tests (Jones, 2004) were conducted to evaluate the criterion validity of the MRST –C, MRST-H and MNA-SF.

RESULTS AND DISCUSSIONS

A total of 156 subjects were recruited from rural (38 subjects) and urban (118 subjects) health clinics for the study. Out of the 118 urban subjects recruited, 49.1% were Malays, 43.2% Chinese and 7.6% Indians. All subjects that were recruited from the rural area were Malays (44.2% men and 55.8% women). The age range of the subjects was between 60 and 83 years old with a mean age of 67.7 ± 5.7 years old. As shown in Table 1, almost all of the elderly were married (85.3%), especially men. The "not married" status, including being single, divorced and widowed, is more common among women. About half of the women did not have any formal education (50.6%) as compared to only 10.1% in men ($p<0.001$). As expected, a high proportion of the elderly (88.5%) stayed either with their partners or with their family members. Elderly people in developing countries such as Malaysia were more likely to be living in multi-generation households, than those in developed countries (Suzana, Earland & Abd. Rahman, 2001). However, there were more

Table 1. Socio-demographic characteristics of subjects according to sex [expressed as number (%)]

Characteristics	*Men (n = 69)*	*Women (n = 87)*	*Total (n = 156)*
Marital Status			
Not married	5(7.2)	18(20.7)[a]	23(14.7)
Married	64(92.8)	69(79.3)	133(85.3)
Education			
No education	7(10.1)	44(50.6)[b]	51(32.7)
Had education	62(89.9)	43(49.4)	105(67.3)
Living Status			
Couple/ Extended	67(97.1)	71(81.6)	138(88.5)
Alone	2(2.9)	16(18.4)[a]	18(11.5)
Job Status			
Working	24(35.3)	12(13.8)	36(23.2)
Not working	44(64.7)	75(86.2)[b]	119(76.8)
Source of Income			
Dependent	20(29.0)	63(72.4)[b]	83(53.2)
Non dependent	49(71.0)	24(27.6)	73(46.8)

[a]$p<0.05$, [b]$p < 0.001$, significance difference between sex (Pearson Chi Squared test)

elderly women (18.4%) than men (10.8%) who were staying alone ($p<0.01$). Most of the elderly who were staying alone were either divorced or widowed. According to Sherina, Lekhraj & Mustaqim (2004), women who were divorced or widowed tend to continue to live alone as compared to men. Widowed women were also less likely to remarry than men. Based on job status, most of the women were not working (86.2%) as compared to men (64.7%) ($p<0.001$). Majority of the women who were not working were housewives and dependant on either their spouse or children to support their living. Whereas men who still had a job were mostly taxi drivers, farmers and odd job laborers. Elderly people tend to depend on their family members for financial support due to aging and less ability to support themselves. Elderly women (72.4%) were more dependent on their family members for their source of income than men (29.0%). Women who were not working and did not have a pension tended to depend more on their family for source of income (Suzana, Earland & Abd. Rahman, 2001; Suzana *et al.*, 2007; Tan, 2006).

The mean ± SD BMI of the subjects was 26.5 ± 4.4 kgm^2, with no significant difference between sexes (Table 2). It appears that women had a lower CC, IADL score, cognitive score and handgrip strength. Based on the WHO (1997) BMI classification as shown in Table 3, overweight problems (45.5% overweight and 18.5% obese) are more prominent among the subjects than chronic energy deficiency (CED) (3.8%). Other studies that have been carried out on elderly Malays (Suzana *et al.*, 2007) and Chinese (Tan, 2006) also showed similar problems of overweight among the elderly subjects. There was no significant difference seen in the distribution of BMI between urban and rural localities in both sexes, which may be due to the small sample size. The trend in increased prevalence of overweight among the rural population has been reported by Ismail *et al.* (1995) among the adults in Malaysia. The increase in the prevalence of over-eating and lack of physical activity among the rural population has contributed to the development of degenerative diseases associated with diet. This phenomenon previously faced only by the urban population has spread over to the rural side (Ismail *et al.*, 1995). On the other hand, the prevalence of muscle wasting as assessed using MUAC (<22cm for women

Table 2. Characteristics of nutritional and functional assessment according to sex (expressed as mean ±SD)

Parameter (unit)	*Men (n=69)*	*Women (n=87)*	*Total (n=156)*
Nutritional			
BMI (kg/m^2)	26.5 ± 4.2	26.4 ± 4.6	26.5 ± 4.4
MUAC (cm)	29.3 ± 3.9	28.3 ± 3.8	28.8 ± 3.9
CC (cm)	35.4 ± 3.8	34.0 ± 4.2[a]	34.6 ± 4.1
Functional			
IADL	14.0 ± 1.5	13.0 ± 2.3[b]	14.0 ± 2.1
Quadriceps	3.0 ± 0.4	3.0 ± 0.6	3.0 ± 0.5
Cognitive assessment score	9.0 ± 1.4	7.5 ± 2.4[b]	8.0 ± 2.1
Handgrip strength (kg)	25.7 ± 7.1	14.8 ± 5.0[b]	18.1 ± 7.8

[a]$p<0.05$, [b]$p<0.001$, significant difference between sex (independent sample t-test)

Table 3. Classification of BMI based on sex and location (expressed as number (%)]

	Men (n=69)			*Women (n=87)*			*Total (n=156)*
	Urban (n=55)	*Rural (n=14)*	*Sub total (n=69)*	*Urban (n=63)*	*Rural (n=24)*	*Sub total (n=87)*	
Chronic Energy Deficiency (16.0 – 18.49 kg/m^2)	1 (1.8)	2 (14.3)	3 (43.5)	3 (4.8)	0 (0)	3 (3.4)	6 (3.8)
Normal 18.5 – 24.9kg/m^2)	17 (30.9)	4 (28.6)	21 (30.4)	24 (38.1)	5 (20.8)	29 (33.3)	50 (32.1)
Overweight (25.0 – 29.9kg/m^2)	29 (52.7)	6 (42.8)	35 (50.7)	27 (42.8)	9 (37.5)	36 (41.4)	71 (45.5)
Obese (30.0 – 39.9 kg/m^2)	8 (14.5)	2 (14.3)	10 (14.5)	9 (14.3)	10 (41.7)	19 (21.8)	29 (18.6)

and <23cm for men) and CC (<30.1cm for men and <27.3cm) was low at 7 % for both. The prevalence of muscle wasting according to MUAC found in this study was higher than what was found in a group of Chinese elderly (5.1%) (Tan, 2006), but comparable with those reported among rural elderly Malays (6.3% men and 9.1% women) (Suzana *et al*., 2007). The prevalence of lower limb muscle wasting as assessed using CC at 7 % was lower than those reported among hospitalised older people of 26% (Sakinah, 2006). Calf circumference is a parameter that shows a good correlation with protein intake when compared to other anthropometric indicators (Bonnefoy *et al*., 2002). Elderly women who have a lower CC are prone to suffer from decreased functional disability (Rolland *et al*., 2003).

Table 4 shows the median score for IADL, quadriceps muscle strength, cognitive assessment and handgrip strength according to the classification of the three screening tools used. Those who were classified as malnourished according to MRST-C had a significantly lower median score for IADL ($p<0.001$), quadriceps ($p<0.001$), cognitive assessment ($p<0.01$) and handgrip strength ($p<0.05$) than those classified as normal. This finding is similar to what was found by Tan (2006) but the difference was insignificant. Those who were classified as malnourished using MNA-SF and MRST-H had a significantly lower cognitive assessment score and handgrip strength ($p<0.05$) than those classified as normal.

As shown in Table 5, both MRST-C and MRST-H correlated negatively, whilst MNA-SF correlated positively with the anthropometric assessments (BMI, MUAC and CC) and functional status (IADL score, quadriceps muscle score, cognitive assessment and handgrip strength). These results show that malnutrition, as indicated by higher score for MRST-C and MRST-H or lower score for MNA-SF, is associated with poor nutritional status or a decrease in BMI, MUAC and CC, and also in unsatisfactory functional status. Among the three screening tools, MNA-SF had the highest correlation with BMI ($r = 0.497$, $p<0.001$), followed by MUAC ($r = 0 .398$,

Table 4. Median score (± SD, with Min-Max) for IADL, Quadriceps Muscle Strength, Cognitive Assessment and Handgrip According to Classification of Screening Tools

	MNA-SF		*MRST-C*		*MRST-H*	
	Normal	*Malnourished*	*Normal*	*Malnourished*	*Normal*	*Malnourished*
IADL	14.0±1.8 (6-14)	13.5±2.5 (6-14)	14.0±2.0 (6-14)	10.5±3.0 (6-14)[c]	14.0±2.0 (6-14)	14.0±3.3 (6-14)
Quadriceps	3.0±0.5 (1-3)	3.0±0.6 (0-3)	3.0±0.5 (0-3)	3.0±0.7 (1-3)[c]	3.0±0.5 (0-3)	3.0±0.7 (1-3)
Cognitive Assessment	9.0±1.7 (3-10)	7.0±2.6 (0-10)[a]	9.0±2.0 (2-10)	7.0±2.7 (0-10)[b]	9.0±2.1 (0-10)	7.5 ±1.9 (4-9)[a]
Handgrip	20.8±7.6 (7.1-39.6)	16.4±7.9 (5.9-41.3)[a]	18.8±7.5 (7.1-39.6)	13.2±9.4 (5.9-41.3)[a]	18.8±7.8 (6.8-41.3)	13.0±7.5 (5.9-30.0)[a]

[a]$p<0.05$, [b]$p<0.01$, [c]$p<0.001$ significant difference between normal and malnourished (Mann Whitney test)

Table 5. Correlations of Screening Tools (MNA-SF, MRST-C & MRST-H) With Anthropometric and Functional Status

	Correlations		
Parameters	*MNA-SF Score*	*MRST-C Score*	*MRST-H Score*
Body Mass Index	0.497[c]	-0.206[b]	-0.359[c]
Mid upper arm circumference	0.398[c]	-0.182[a]	-0.349[c]
Calf circumference	0.473[c]	-0.219[a]	-0.331[c]
IADL Score	0.116	-0.320[c]	-0.056
Quadriceps Muscle Strength Score	0.042	-0.298[c]	-0.130
Lock & Key test	0.121	-0.222[b]	-0.325[c]
Cognitive Assessment Score	0.229[c]	-0.210[b]	-0.059
Handgrip Strength	0.209[b]	-0.190[a]	-0.155[b]

[a]$p<0.05$, [b]$p<0.01$, [c]$p<0.001$, Spearman correlation coefficient

p<0.001), CC (r = 0.473, p<0.001), cognitive assessment (r = 0.229, p<0.001) and handgrip strength (r = 0.209, p<0.01). MRST-C had the highest correlation with IADL score (r = -0.320, p<0.001), whilst MRST-H had the highest correlation with lock and key test (r = -0.325, p<0.001). However, it should be noted the r values or correlation coefficient was below 0.5, which is a weak correlation (http://www.bized.co.uk/timeweb).

The correlations found with the parameters seen for each of the screening tools could be due to the inclusion of such variables in each of the tools. MNA-SF includes variables on BMI, physical mobility and cognitive problems. MRST-C had a variable on age as a contributor to the total score and aging is one of the factors that causes a decline in the ability of IADL (Asakawa *et al*., 2000; Romoren & Blekescaune, 2003). MRST-H includes more specific measurements, which are the MUAC and CC as variables. The lock and key test is a simple test to detect a decrement in hand function, which involves muscle strength can be assessed through MUAC. Thus, those subjects who were not able to perform the lock and key test would be the one having extreme loss of muscle mass.

A good screening tool is one that has sensitivity and specificity values of at least 80% to prove its usefulness (Nahid *et al*., 1999). A high sensitivity allows further diagnosis to be done and enables clinical intervention. On the other hand, a high specificity will reduce the chances of giving further treatment to those who do not need such treatment with a minimal cost of interventions such as health education at the community level (Suzana, Dixon & Earland, 1999).

The sensitivity, specificity and PPV among malnourished subjects based on the three screening tools used in this study with several anthropometric assessments are presented in Table 6. MNA-SF had a high sensitivity and specificity value when

Table 6. Sensitivity, Specificity and Positive Predictive Value of Screening Tools (MNA-SF, MRST-C & MRST-H)

	BMI			*MUAC*			*CC*		
	Urban	*Rural*	*Total*	*Urban*	*Rural*	*Total*	*Urban*	*Rural*	*Total*
MNA-SF									
Sensitivity (%)	100	100	100	80.0	100	81.8	88.9	100	91.0
Specificity (%)	74.8	71.4	74.1	75.0	67.6	97.3	75.2	69.4	74.0
Positive Predictive Value (%)	12.5	23.1	20.8	22.9	10.8	18.7	22.9	15.4	20.8
MRST-C									
Sensitivity (%)	-	50.0	30.0	20.0	-	11.1	44.4	50.0	45.4
Specificity (%)	88.3	94.3	89.8	88.0	91.9	93.5	89.9	97.1	91.1
Positive Predictive Value (%)	-	33.3	16.7	13.3	-	18.2	26.7	33.3	27.8
MRST-H									
Sensitivity (%)	71.4	33.3	60.0	44.4	100	54.5	28.6	50.0	45.5
Specificity (%)	99.1	100	98.0	99.0	100	97.9	75.0	100	97.3
Positive Predictive Value (%)	83.3	100	66.7	80.0	100	66.7	40.0	100	55.5

validated against BMI (sensitivity 100%, specificity 74.1%), MUAC (sensitivity 81.8%, specificity 97.3%) and CC (sensitivity 91.0%, specificity 74.0%). At present, no studies have been conducted to validate the MNA-SF among the local community elderly. Recently, the MNA-SF was validated among a group of newly admitted elderly patients at Hospital Kuala Lumpur and had a sensitivity of 48.1% and specificity of 85.0% (Sakinah, 2006). The occurrence of malnutrition among hospitalised elderly patients may be confounded by acute disease process, thus it is rather difficult to obtain high sensitivity using a screening tool such as MNA-SF.

MRST-C had lower sensitivity values than MNA-SF but had good specificity when validated against BMI (sensitivity 30.0%, specificity 89.8%), MUAC (sensitivity 11.1%, specificity 93.5%) and CC (sensitivity 45.4%, specificity 91.1%). A validation study done on a group of Chinese elderly also showed a low sensitivity with a high specificity against BMI (sensitivity 14.7%, specificity 85.4%) and CC (sensitivity 25.0%, specificity 87.3%) (Tan, 2006). However, a higher sensitivity (32%) was found in a validation study done among rural elderly Malays (Suzana *et al.*, 2007). It would appear that MRST-C is valid among elderly people in the community, particularly the Malays.

MRST-H demonstrated a lower sensitivity than MNA-SF but with a higher specificity than MNA-SF and MRST-C when validated against BMI (sensitivity 60.0%, specificity 98.0%), MUAC (sensitivity 54.5%, specificity 97.9%) and CC (sensitivity 45.5%, specificity 97.3%). A previous validation study conducted at Hospital Kuala Lumpur on 100 newly admitted elderly patients had a sensitivity and specificity value of 94% and 90.5% respectively (Sakinah, 2006). The sensitivity and specificity values obtained from this present study are lower than what was obtained by Sakinah (2006), and could be due to the fact that this screening tool was developed specifically for hospitalised elderly and targeted at those who are already malnourished.

Thus, from the results obtained, MNA-SF could be used to detect those individuals who are truly malnourished and non-malnourished, from various assessments such as BMI, MUAC and CC. Since both MRST-C and MRST-H had a lower sensitivity and higher specificity, these two screening tools are able to detect those who are truly non-malnourished from the population studied here. Among the three screening tools, MRST-H had the highest PPV of 55.5%. A high PPV (66.7%) was seen in both BMI from arm span and MUAC. This means that there is a probability of about 55.5% for a subject to be either at high risk of malnourished or not, based on MRST-H. The PPV for MNA-SF was 18.2% and 14.1% for MRST-C.

The difference in the values of sensitivity, specificity and PPV could be due to the population studied, differences in nutritional problems and the purpose or the variables in the screening tools. The sample in this study was elderly people who visited the health clinics and they were a younger cohort. Those who attended the clinics would be the ones who were receiving medical services, more aware of their health and less frail. Thus the studied subjects may not represent the community dwelling elderly and those frail and older elderly who are more prone to malnutrition.

It is not possible to establish the exact specificities or sensitivities, and predictive values of malnutrition screening tools because there is no universally accepted definition or reference gold standard for malnutrition. The selection of screening tools will depend on the intent of the screening procedure, the interventions planned for the targeted groups and the availability of the resources and manpower. MNA-SF identifies people who are at risk for malnutrition with weight loss. It also takes into account other factors that influence nutritional status of the elderly such as cognitive and psychosocial factors. Using MNA-SF, the number of elderly subjects identified as truly malnourished may be overestimated, as the number would include those who are at risk but have not yet become malnourished. This tool is appropriate to be used when the intended intervention includes approaches at a mass community level, for example nutritional and health education talks. It also requires minimal training and can be administered by untrained staff on both younger and older elderly populations. MRST-C is more appropriate to be used in a frail, older elderly population in the community, particularly among the Malays. This is the least demanding tool compared to MRST-H and MNA-SF as it does not involve any anthropometric measurements. However, it may not be able to detect those subjects who could be malnourished due to weight loss. MRST-H is a tool that may be more suitable to be used in a situation where the intended intervention involves specific clinical interventions, for example medical and diet therapies. It tends to identify those elderly who are already malnourished. This tool is more demanding compared to both MRST-C and MNA-SF as it requires training for staff to carry out the anthropometric assessments such as MUAC and CC measurements.

CONCLUSION

All the three screening tools validated showed a desirable correlation with anthropometric and functional assessments, i.e. malnutrition risk is related to poor nutritional and functional status. However, among the screening tools validated, MNA-SF would be an appropriate tool to be used in the health clinic for identifying elderly individuals who are at high risk of malnutrition with a sensitivity of 93.2% and specificity of 79.4%. The number of subjects from the rural area was smaller than the urban area. Thus the number of rural subjects could have been represented unfairly. This could be the reason why there were no significant differences in most of the demographic and socioeconomic status, psychosocial factors and health status, between the rural and urban elderly. Finally, this cross-sectional study only showed descriptive relationships and does not explain the causal factors and the mechanism behind any relationships. Therefore, a prospective study is recommended to evaluate the cost effectiveness of the screening tool in the prevention, identification and treatment of malnutrition.

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Appendix

Mini Nutritional Assessment Short Form (MNA-SF)

No.	*Item*	*Score*
1	Has your food intake decline over the past 3 months due to loss of appetite, digestive problem, chewing or swallowing difficulties? 0 = severe loss of appetite 1 = moderate loss of appetite 2 = no loss of appetite	
2	Weight loss during last months 0 = weight loss greater than 3 kg 1 = does not know 2 = weight loss between 1 and 3 kg 3 = no weight loss	
3	Mobility 0 = bed or chair bound 1 = able to get out of bed/ chair but does not go out 2 = goes out	
4	Has suffered psychological stress or acute disease in the past 3 months 0 = yes 2 = no	
5	Neuropsychological problems 0 = severe dementia or depression 1 = mild dementia 2 = no psychological problems	
6	Body Mass Index (BMI) 0 = BMI less than 19 1 = BMI I9-21 2 = BMI 21 to less than 23 3 = BMI greater than 23	
Total Score (maximum of 14 points) 12 points and above = Normal (not at risk of malnutrition) 11 points and above = At risk of malnutrition		

Malnutrition Risk Screening Tool Hospital (MRST-H)

No	*Question*	*Malnutrition score*	
		Yes	*No*
1.	Do you depend on someone for your source of income (Is your source of income not enough to buy the food supply?)	1	0
2.	Are you unable to feed or eat by your own self?	1	0
3.	Do you have any unintentional weight loss in the last 1 or 6 months? ($\geq$ 5% one month or $\geq$ 10% 6 months)? Usual weight = ……kg Current weight =…….. kg % weight loss = [(Usual weight — current weight)¸usual weight] x 100	3	0
4.	Mid upper arm circumference 0 = MUAC $\geq$ 23.0 (men), 22 (women) 2 = MUAC < 23.0 (men), 22 (women)	2	0
5.	Calf circumference (CC) in 0 = CC $\geq$ 30.1 (men), 27.3 (women) 1 = CC < 30.1 (male), 27.3 (women)	1	0
Total Score $\geq$ 5= individual has a high risk of malnutrition			

Malnutrition Risk Screening Tool Community (MRST-C)

No.	*Item*	*Malnutrition Score*	
		Yes	*No*
1.	Are you 75 years and above?	2	0
2.	Do you suffer any difficulty in chewing food?	1	0
3.	Have you had loss of appetite recently?	2	0
Total Score $\geq$ 3 indicate individual at high risk of malnutrition			