

Revisiting the concept of malnutrition in older people

Cheryl Chia-Hui Chen DNSc, GNP

Assistant Professor, National Taiwan University School of Nursing & National Taiwan University Hospital, Taipei, Taiwan

Ya-Ying Bai RN, BSN

Graduate Student, National Taiwan University School of Nursing, Taipei, Taiwan

Guan-Hua Huang PhD

Associate Professor, National Chiao Tung University Institute of Statistics, Hsinchu, Taiwan

Siew Tzuh Tang RN, DNSc

Associate Professor, Chang Gung University School of Nursing, Kwei-Shan Tao-Yuan, Taiwan

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Correspondence:

Siew Tzuh Tang

Associate Professor

Chang Gung University School of Nursing

259 Wen-Hwa 1st Road

Kwei-Shan Tao-Yuan

Taiwan

Telephone: 8863 2118800 ext. 3417

E-mail: sttang@mail.cgu.edu.tw

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Aim. The aim of this study is to revisit the concept of malnutrition in older people, trace the new development and test the use of refined framework with empirical data.

Background. Malnutrition in older people is a common and significant problem worldwide. Continuing Chen's earlier work in 2001, a refinement was conducted and a prospective study was designed to test the use of this refined framework.

Design. A cohort study of 114 hospitalized older patients in Northern Taiwan.

Methods. The sample consists of 114 older patients aged 65 years and older, who were admitted for the cardiac and orthopaedic services at a tertiary 2300-bed hospital. From March to August 2004, assessed by one trained nurse, participants completed a structured face-to-face interview evaluating their age, visual/hearing impairments, oral health, cognitive status, comorbidities, medication use, social economic status, functional status, social support, depressive symptoms and nutritional status within 48 hours of admission. Participants who stayed > 5 days were reassessed before discharge ($n = 70$). The data from admission were the main focus of this report.

Results. Regression analysis revealed that that more medication taken, female gender, lower functional status ($\beta = 0.34$, $P < 0.001$) and higher depressive symptoms were independent predictors of poor nutritional status, with the full model accounting for 48.2% of the variance. The result is in-line with the original theoretical underpinnings and it suggests that this refined framework detailing sub-concepts and measurable indices appears to fit the empirical data and suitable for clinical use.

Conclusion. The findings lend support to the use of this framework in managing malnutrition in older people.

Relevance to clinical practice. Nurses have an essential role in providing care for older people a framework like this would provide a road map guiding the intervention efforts.

Key words: concept development, elder care, nursing, nursing care, nutrition, theory-practice gap

Introduction

Finding ways to deliver care anchored in the best possible evidence remains a continuing challenge. Further refinements of a conceptual framework based on empirical data are of importance in moving health care forward. A concept analysis of malnutrition in older people has been published in 2001 (Chen *et al.*) to delineate on the key elements of the conceptual framework including critical attributes, antecedents and consequences, leading to refinement of the framework. While these key elements remain theoretically meaningful to the development of malnutrition in older people, new empirical data have been available to their constituent sub-elements, enabling the detail of the framework to be revised.

In 2001, a concept analysis of malnutrition in older people was first published in the *Journal of Advanced Nursing*, in which the critical attributes of malnutrition in older people were identified to include insufficient dietary intake, muscle wasting, weight loss, poor appetite and downward trajectory. Loss, chronic illness, dependency and loneliness were proposed as the antecedents of malnutrition in older people (Chen *et al.* 2001). As the key elements of the framework were proposed and opened up to scrutiny, it has received much attention and interest and appears to have face validity to those in the field working with older people (20 citations since 2001). This paper aims to refine the framework further in reflecting a synthesis of the current literature and to make the framework more distinct than the original. It also seems timely to report on a prospective cohort study designed primarily from this refined framework to examine its empirical values.

Background & conceptualization

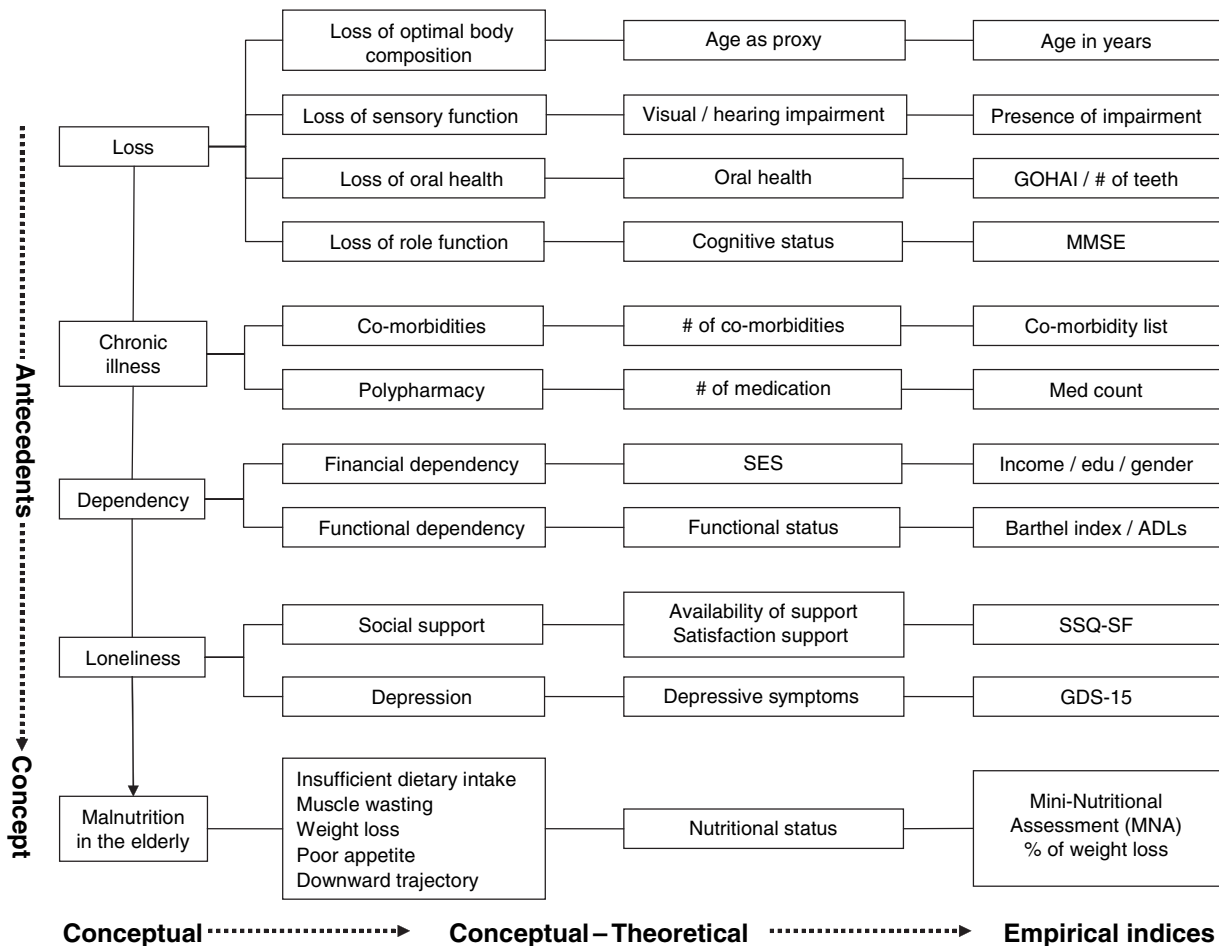
Ensuring proper nutritional status for older people has been shown to reduce healthcare costs and enhance quality of life. Studies, however, have revealed that malnutrition is present in 10–60% of hospitalized older patients, depending on the definition used and the population studied (Sullivan

et al. 1999, Van Nes *et al.* 2001, Guigoz *et al.* 2002). The variance in this figure is the result of the differences in the study method employed, the type of setting in which the study was conducted and the measures used for defining malnutrition. The seemingly complex and ambiguous nature of the concept places a barrier on the development of targeted interventions for preventing and treating malnutrition. This gap in the literature is serious, because malnutrition has been documented to occur frequently and it leads to increased morbidity and mortality (Institute of Medicine 2000, Liu *et al.* 2002). There is clearly a lack of understanding on the complex factors having an impact on malnutrition in older people. To build on the previous work and adding the new insight to move forward, this study aims to refine and operationalize these proposed conceptual elements and test the validity of these elements with real world data. As the first preliminary step, the critical attributes of malnutrition in older people were used as a guide for choosing nutrition measures. The antecedents of malnutrition in older people, including loss, chronic illness, dependency and loneliness were operationalized to test their relationships with the development of malnutrition in older people. The process of operationalizing these antecedents was described in the following text.

Loss

As proposed by Chen *et al.* (2001) and further refined and developed in Fig. 1, the antecedent construct of loss involved four concepts including loss of optimal body composition, loss of sensory function, loss of oral health and loss of role function. These more concrete concepts must be defined in measurable ways and hypotheses stating specific and observable relationship must be derived from the proposition of the conceptual framework before action can occur. Therefore, four sub-concepts within the construct of loss were further defined and operationalized as the following:

Advanced age is associated with a remarkable number of changes in body composition, including reduction in lean



GOHAI= Geriatric oral health assessment index, MMSE= Mini-mental state examination, SSQ - SF= Social support questionnaire-short form, GDS-15= Geriatric depression scale-15

Figure 1 Refined conceptual-theoretical-empirical structure framework of malnutrition in older hospitalized patients. GOHAI, General Oral Health Assessment Index; MMSE, mini-mental state examination; SSQ-SF, Social Support Questionnaire-Short Form; GDS-15, Geriatric Depression Scale-15.

body mass and increase in the body fat. This age-related loss in muscle mass has been termed ‘sarcopenia’ and it is a direct cause of an age-related decrease in muscle strength. The most accurate measures for body composition include hydrostatic weighing, dual-energy X-ray absorptiometry (DXA), air-displacement plethysmography (ADP) and multi-compartment models (Weyers *et al.* 2002, Fields & Hunter 2004). However, given the complexity and limited clinical implication of these measures and the high correlation between age and body composition changes, a decision was made to use chronological age as a proxy to illustrate the impact of loss of optimal body composition on nutrition. In terms of loss of sensory function, although smell, taste, visual and hearing sensory losses have all been suggested to be detrimental to nutrition (Chen *et al.* 2001), several studies have indicated

that loss of smell and taste did not appear predictive nutritional status (Griep *et al.* 2000). In contrast, visual and hearing losses were suggested to be more significant (Payette *et al.* 1995, Valentijn *et al.* 2005). Visual and/or hearing losses, therefore, were chosen to represent the concept of loss of sensory function in this study. Loss of oral function was measured by general oral health functioning. Specific dental health indices such as the number of decay, missing and filling teeth (DMFT) index were not used given that general oral health function has been suggested to have a significant impact on nutrition (de Groot *et al.* 2000). Loss of role function was represented by the cognitive status given that cognition; ‘knowing what to do’ is essential to maintain the role function, particular for older people (Sarna *et al.* 1993, Knight 2000).

Chronic illness

Comorbidities and polypharmacy were suggested as the two sub-concepts within the construct of chronic illness in Chen's original work. Accordingly, polypharmacy, defined as the concomitant use of multiple drugs, was measured by a simple count of medications (Hanlon *et al.* 2001). Comorbidities were assessed by counting the diagnoses of 19 common chronic illnesses in older people. In short, numbers of comorbidities and medication taken were operationally chosen as two indices to represent the concepts.

Dependency

Within the construct of dependency, financial dependency as characterized by socioeconomic status (SES) was examined in this study. A national survey indicated that nutritional intake was significantly different between persons with low and high SES (Guthrie & Lin 2002). Therefore, income, educational level and gender were used as empirical indices for SES in this study. Gender was studied because of its importance in nutritional status and in the degree of SES impact on health at large. For example, a weaker socioeconomic gradient in health and mortality has been observed for female gender (Duncan *et al.* 2002). However, a feminization of poverty is also being suggested. Women have been considered to be less well off financially and to suffer more intensely because they are discriminated against and fewer opportunities are open for them, particularly in the East (World Health Organization 2001). Therefore, the impact of gender was studied within the context of SES in this study. Functional dependency was measured by activities of daily living (ADL)-related functional status.

Loneliness

The construct of loneliness, as suggested in Chen's original work, was measured by the presence of social support and depressive symptoms. Depressive symptoms have been suggested as one of the most important factors impacting nutrition in older people (Wilson *et al.* 1998, Chen *et al.* 2005). On the other hand, empirical evidence on the impact of social support on nutrition is inconclusive and in need for closer examination.

In summary, age in years, visual/hearing impairment, oral health, cognitive status, number of comorbidities, number of medications taken, social economic status (education, income and gender), functional status and presence of social support and depressive symptoms were examined as the predictors of nutritional status, which was measured by the mini-nutri-

tional assessment (MNA) in a sample of 114 older patients who had been admitted for cardiac and orthopaedic services at a tertiary medical centre located in Northern Taiwan.

Objectives & methods

The objective of this study was to evaluate the use of the proposed conceptual framework using empirical data. Specifically, the relative importance of age, visual/hearing impairments, oral health, cognitive status, comorbidities, medication use, social economic status, functional status, presence of social support and depressive symptoms in predicting nutritional status of hospitalized older patients was cross examined. As illustrated in Fig. 1, these predictors were selected from an exhaustive literature synthesis (Payette *et al.* 1995, de Groot *et al.* 2000, Institute of Medicine 2000, Chen *et al.* 2005), along with the initial concept development by Chen *et al.* (2001).

Data were collected by one trained research nurse who used structured instruments to obtain information and measures on demographics, visual/hearing impairments, oral health, cognitive status, comorbidities, medication use, functional status, social support, depressive symptoms and nutritional status. All participants were interviewed within 48 hours of admission ($n = 114$) and before discharge if length of stay was over 5 days ($n = 70$). The interview schedule consisted of four sections: (1) demographics; (2) descriptive data; (3) predictor scales and (4) anthropometric measures including weight, knee height and mid-arm and calf circumference. Participants also underwent a brief oral health examination involving counting the remaining teeth and assessing the fit of denture. Because the pool of participants at the discharge assessment was limited ($n = 70$), this paper only reports results obtained at admission assessment ($n = 114$).

Sample/participants

A hospital sample was recruited. The study population was defined as older patients aged 65 years and above who had been admitted to cardiac and orthopaedic floors of a tertiary medical centre in Taipei, Taiwan during the months of March to August, 2004. Every older patient admitted to these two floors was invited to participate. Patients were not recruited if their mini-mental state examination (MMSE) scores were < 20 ($n = 43$), expected length of stay < 3 ($n = 235$), isolated within infection control protocol ($n = 8$), intubated; unable to communicate or under critical conditions ($n = 133$). Consent by proxy was not used in this study due to both its methodological and ethical problems. Of 203 eligible patients, 114 completed baseline assessments during

the study period (1 March 2004 to 31 August 2004). The nonparticipants ($n = 89$) did not differ significantly from the participants in age ($p = 0.82$), gender ($p = 0.53$) or education ($p = 0.99$). The reasons for nonparticipation included 'not interested' ($n = 13$), 'not feeling well' ($n = 41$), 'in pain or discomfort' ($n = 25$) and for 'privacy protection' (i.e. do not wish to give signature for any causes; $n = 10$).

Instruments

Reliability of data collection was maintained by standardized protocols, use of validated instruments and training of research staff. The psychometric properties of instruments were briefly described as the following:

Demographics & sensory impairment data

A demographic form was designed to collect the data including age, gender, marital status, living status, income, education, occupation and ethnic group. Additionally, sensory impairments were assessed by the self-report of visual and hearing impairments. Participants who presented with hearing or visual difficulties during the data collection were automatically coded as having hearing or visual impairments.

Oral health

A 12-item Chinese version of General Oral Health Assessment Index (GOHAI) was used to assess oral health. The GOHAI is designed to assess the dimensions of oral function (eating and speaking), pain, discomfort, worry and oral health-related social functioning (Atchison & Dolan 1990). Reliability estimates (Cronbach's $\alpha = 0.83$ – 0.79 ; inter-rater reliability $\alpha = 0.61$) and established content, discriminant and construct validity have been reported for both English and Chinese versions (Calabrese *et al.* 1999, Wong *et al.* 2002a). The sum scores ranged from 12–60 with a higher score indicative of better perceived oral health. Information on number of remaining teeth and fit of denture were also obtained.

Cognitive status

The 30-item Chinese MMSE was used to measure cognitive status. The MMSE is the most widely used cognitive assessment tool in Taiwan. The final score is the sum of the scores from 30 items and it ranged from 0–30 (Folstein *et al.* 1975). Satisfactory test-retest ($r = 0.89$ – 0.93), inter-rater reliability ($r = 0.83$) and content and discriminant validity have been reported (Guo *et al.* 1988).

Comorbidities

The history and number of comorbidities was elicited from the medical record. A standardized comorbidity checklist was

used to assess common chronic illnesses including myocardial infarction, angina, congestive heart failure (CHF), hypertension, diabetes, hyperlipidaemia, arthritis, dementia, stroke, asthma or lung disease, renal disease, Parkinson's disease, osteoporosis, hip fracture, pressure sore, cancer and others.

Medication use

Using a standardized protocol, medication review was conducted by the trained research nurse with the data from the medical record and information from the patients. The number and type of prescription and over-the-counter medications taken currently by participants was documented.

Functional status

The 10-item Chinese version of Barthel Index (BI) was used to measure functional status. Satisfactory reliability (Cronbach's $\alpha = 0.87$ – 0.91 ; Kappa = 0.70 – 0.88) and validity have been reported for the BI (Dai *et al.* 1999, Sainsbury *et al.* 2005). The BI comprises 10 ADLs with the sum scores range from 0–100 and higher score indicating better functional status (Mahoney & Barthel 1965).

Social support

The six-item Chinese Social Support Questionnaire-Short Form (SSQ-SF) was used to measure social support. In six common situations, subjects were asked to list up to nine people who can be counted on and specify overall degree of satisfaction with such support. The tool has been used with older population: the coefficient α ranged from 0.90 – 0.93 and established construct and content validity have been reported (Sarason *et al.* 1987). The SSQ-SF was translated into Chinese for the purpose of this study. The translation procedure incorporated two iterations of translations from English to Chinese by the first author and the back translation from Chinese to English by an independent researcher blind to the original English SSQ-SF. Additionally, five bilingual experts in nursing, psychology, public health and gerontology were asked to evaluate the conceptual equivalence of Chinese version SSQ-SF with original SSQ-SF and satisfactory results have been obtained (CVI = 0.80 – 1.00). The Cronbach's α of Chinese SSQ-SF was 0.85 in the present study.

Depressive symptoms

The 15-item Chinese version of Geriatric Depression Scale Short-Form (GDS-15) was used to measure the presence of depressive symptoms. The 95% confidence intervals for sensitivity and specificity of the long-form GDS (GDS-30) are 84–93% (Yesavage *et al.* 1983). The GDS-15 has demonstrated a high correlation with the long-form GDS (Gerety *et al.* 1994, Wong *et al.* 2002b).

Nutritional status

The 18-item Chinese version of MNA was used to measure nutritional status, given its inclusion of all five proposed critical attributes among the items. The summed score could be used either as a categorical or interval variable. The score can categorize older people as (1) ≥ 24 , well-nourished; (2) 23.5–17, at risk and (3) < 17 , malnourished. High levels of sensitivity (96%), specificity (98%) and satisfactory inter-rater reliability (Kappa coefficient = 0.65–0.42) have been reported (Guigoz *et al.* 1996, Chan *et al.* 2002). Additionally, weight loss history in the prior three-month was also collected.

Ethical consideration

The study was approved by the Research Ethics Review Board at the National Taiwan University Hospital. The process of obtaining consent for participation was lengthy, as the investigators were mindful of the vulnerability of older population. All eligible participants were approached by the research nurse to explain the nature and purpose of the study and invited to participate. The voluntary and confidential nature of the study was braced. At any time, if participants appear stressed or in discomfort, the assessment was terminated. No assessment was terminated for stress or discomfort reasons, but few participants' assessments were break into two sessions to reduce responder burden ($n = 3$). The period of time needed to collect data was approximately 25–40 minutes. Participants with identified health concerns, such as depressive symptoms, were referred to their care providers when consent was granted ($n = 8$).

Data analysis

Data were analysed using SAS, version 8.0 (SAS Institute, Inc., Cary, NC, USA). Data were double-entered and comparative analyses were completed for accuracy. Descriptive and bivariate analyses including *t*-test for two group data, ANOVA for three or more groups and Pearson correlation for continue variables were computed, to provide an overview showing unadjusted bivariate relationship among variables. Of note, scores on depressive symptoms were fairly skewed (skewness = 2.9) in terms of their distributions on normality and therefore non-parametric test-Spearman rank-order correlation was applied.

As many factors could be used as either a continuous or categorical variable, care was given to use continuous variables whenever possible to avoid losing information. The proposed framework was then tested by regression models with MNA scores as the dependent variable. As shown in Fig. 1, independent variables were entered in block

and the order of antecedent construct being entered was decided as loss, chronic illness, dependency and loneliness. To evaluate the unique variance of MNA scores explained by each antecedent construct, partial *F*-test was used (Kleinbaum *et al.* 1998). Prior to analyses, data were assessed for congruence with regression assumption. Normality and homoscedasticity were evaluated by residual scatterplots. The residuals were distributed evenly. Therefore, assumptions for regression were reasonably met. Significance was set at $p < 0.05$.

Results

The sample was evenly distributed by gender, with 56.14% ($n = 64$) female. The majority were living with others (93.86%; $n = 107$) and one-third (31.58%, $n = 36$) were widow. The sample represented diverse educational, income and ethnic backgrounds. Ages ranged from 65 to 90 years with a mean of 75.22 years and standard deviation (SD) of 6.29 years. The detailed demographics of the sample are shown in Table 1.

Descriptive analysis

The BMI ranged from 15.22 to 35.17 kg/m² with a mean of 24.07 and SD of 4.10. Using the criteria recommended by the Department of Health in Taiwan (2002), 11 subjects (9.65%) had BMI < 18.5 kg/m² and were classified as underweight. Conversely, 57 subjects (50%) having BMI > 24 kg/m² were considered overweight. In addition, 19 subjects (16.67%) reported having a weight loss equal to or $> 5\%$ in the last 3 months. In terms of MNA scores, five subjects (4.39%) scored < 17 and were classified as malnourished and 49 subjects (42.98%) scored 17–24 and were at risk of malnutrition; the remaining 60 (52.63%) were considered well-nourished.

Bivariate analysis

Age in years, visual/hearing impairments, oral health, cognitive status, number of comorbidities, CHF diagnosis, number of medications taken, functional status and depressive symptoms appeared to be significantly associated with MNA nutritional status all in the expected direction, which provided tangible evidence for the validity of Chen's framework (Tables 2 and 3). Conversely, number of teeth, marital status, income and certain comorbidities were later removed from the model building given its dismal association. It is note worthy that income has not been a sensitive index for financial security, particularly for Taiwanese older people.

Table 1 Sample demographic characteristics ($n = 114$)

	No.	%
Age group		
65–74 years	56	49.1
75–84 years	48	42.1
85 years and above	10	8.8
Gender		
Male	50	43.9
Female	64	56.1
Ethnicity		
Taiwanese	86	75.4
Mainlander	15	13.2
Hakka	12	10.5
Native Taiwanese	1	0.9
Married status		
Widowed	36	31.3
Married	74	64.9
Single/separate	4	3.5
Education level		
Illiterate	27	23.7
Six grade	46	40.4
Nine grade	15	13.2
≥12 grade	26	22.8
Monthly income		
< 5000 NTD*	22	19.3
5000–10 000	20	17.5
10 001–20 000	10	8.8
≥20 001	16	14.0
Prefer not to tell	46	40.4
Religion		
Buddhist	38	12.0
Daoism	39	30.0
Protestant/catholic	8	56.0
Other	29	1.6
Sensory impairments		
Visual impaired	41	36.0
Hearing impaired	19	16.7
Both visual/hearing impaired	10	8.8
Neither impaired	64	56.1

*New Taiwan Dollar, 32 NTD = 1USD = 0.56GRP.

This might be due to the fact that children are supposed to support their aged parents in Chinese culture.

Meanwhile, female gender ($p = 0.21$), education ($p = 0.20$) and scores of social support ($p = 0.21$), although they did not reach the significant level at $p < 0.05$, were forced into the regression model to examine the merits of their impact. Additionally, within the sensory impairments, only visual impairment ($p = 0.02$) was retained in further model building. As to the concern for multicollinearity, number of comorbidities was later removed from the regression model given its less desirable tolerance and high correlation with number of medications (tolerance = 0.52; $r = 0.44$).

Table 2 Bivariate relationship between predictors and mini-nutritional assessment (MNA) scores ($n = 114$)

Characteristic	MNA, mean (SD)	Test statistics	p -values
Gender			
Female	23.1 (3.4)	1.26 [†]	0.21
Male	23.9 (3.3)		
Education			
Illiterate	22.7 (3.8)	1.47 [‡]	0.23
Six grade	23.9 (3.0)		
Nine grade	23.9 (2.0)		
≥12 grade	22.3 (4.8)		
Income, monthly			
< 5000 NTD*	23.4 (2.4)	−0.04 [‡]	0.99
5001–10 000	23.4 (2.3)		
≥10 001	23.2 (4.6)		
No to tell	23.5 (3.5)		
Marital status			
Widow	22.8 (4.1)	1.04 [‡]	0.38
Married	23.6 (3.0)		
Single/separate	24.5 (4.4)		
Selected comorbidities			
Visual impaired			
Yes	22.4 (3.5)	−2.33 [†]	0.02
No	23.9 (3.3)		
Hearing impaired			
Yes	22.2 (3.8)	−1.65 [†]	0.10
No	23.6 (3.3)		
Congestive heart failure			
Yes	21.6 (4.2)	−2.34 [†]	0.02
No	23.7 (3.2)		
Kidney function impairment			
Yes	22.4 (4.0)	−1.47 [†]	0.14
No	23.6 (3.8)		
Any cancer other than of the skin			
Yes	22.0 (3.8)	−1.52 [†]	0.13
No	23.6 (3.3)		

*New Taiwan Dollar, 32 NTD = 1USD = 0.56GRP; [†] t -test; [‡]ANOVA.

Table 3 Bivariate correlation between continue predictors and mini-nutritional assessment scores ($n = 114$)

Continued variables	Mean ± SD	Correlation	p -values
Age in years	75.2 (6.3)	−0.25	0.01
Geriatric oral health assessment index	51.5 (4.9)	0.19	0.05
Number of remaining teeth	10.3 (9.3)	0.09*	0.33
Mini-mental state examination	26.3 (3.2)	0.33	<0.001
Number of comorbidities	4.8 (2.0)	−0.34	<0.001
Number of medications taken	4.8 (3.2)	−0.24	0.01
Barthel Index	94.4 (12.3)	0.56	<0.001
Social Support Questionnaire-Short Form	60.1 (16.4)	0.12	0.21
Geriatric Depression Scale-Short Form	1.7 (2.3)	−0.29*	0.0018

*Non-parametric test, spearman rank-order correlation was applied.

Multivariate analysis

Results of multivariate analysis are shown in Table 4. In the model building, each antecedent construct comprising sub-concepts were entered the model as a group in the following sequential. At step 1, the construct of loss, measured by age, visual impairment, oral health and cognitive status was first put into the model and explained 19.1% of the variance in MNA scores. At step 2, the construct of chronic illness, measured by CHF diagnosis and number of medications taken was then added and explained extra 4.7% of the variance ($p = 0.04$). At step 3, the construct of dependency, measured by education, gender and functional status was added and explained extra 17.1% of the variance in MNA scores ($p < 0.001$). At step 4, the construct of loneliness, measured by social support and depressive symptoms was added lastly and explained extra 7.3% of the variance ($p = 0.001$). As a whole, the model explained 48.2% of the variance in MNA nutritional scores and in each step, every construct contributed gradually to the prediction of nutritional status.

Comparing four regressions in Table 4, it is worthy noting that regression coefficients for the construct of loss, although were significant at first, their significance gradually became null after adding other constructs. Conversely, the constructs of chronic illness, dependency and loneliness did

not alter their significance through four models. This indicates that the construct of loss by itself was a significant predictor of MNA scores, but its association with MNA scores was diluted when other three constructs entering the model.

Discussion

Data from our study indicated that higher depressive symptoms, lower functional status, female gender and higher medication taken were independently associated with poor nutritional status after multiple adjustments. By using regression analyses, the changes on every single predictor when adding new variables were visible, which provide a better contrast and in-depth understandings on potential confounding effects among variables. The findings also lend support to the validation of this refined conceptual structure, in which each construct contributed to the prediction of nutritional status, as shown in Fig. 1.

Specifically, in our study, depressive symptoms appear to be most significant even after adjusting for many risk factors. The prevalence of depression in the community-dwelling older people is reported as 8–16% (Blazer 2002). One of the leading factors reported to be associated with malnutrition and weight loss in older people is depressive symptoms (Huffman 2002, Callen & Wells 2005, Chen *et al.* 2005).

Step predictors	MNA scores, standardized beta weights (p -values)			
	Step I	Step II	Step III	Step IV
Loss				
Age in years	-0.18 (0.04)	-0.17 (0.06)	-0.08 (0.35)	-0.13 (0.11)
Visual impair	-0.18 (0.04)	-0.12 (0.18)	-0.06 (0.44)	-0.04 (0.62)
GOHAI score	0.11 (0.20)	0.10 (0.25)	0.07 (0.32)	-0.04 (0.61)
MMSE score	0.26 (0.004)	0.28 (0.002)	0.18 (0.06)	0.11 (0.24)
Chronic illness				
CHF diagnosis		-0.08 (0.40)	0.01 (0.89)	0.03 (0.68)
# meds taken		-0.18 (0.07)	-0.19 (0.04)	-0.19 (0.03)
Dependency				
Education			-0.10 (0.31)	-0.04 (0.64)
Female gender			-0.15 (0.09)	-0.18 (0.03)
BI score			0.43 (<0.001)	0.34 (<0.001)
Loneliness				
SSQ-SF score				0.04 (0.62)
GDS-15 score				-0.32 (<0.001)
R^2 change (P)*		0.05 (0.04)	0.17 (<0.001)	0.07 (0.001)
Cumulative R^2	0.19	0.24	0.41	0.48
Adjusted R^2	0.16	0.20	0.36	0.43

Table 4 Regression models with betas shown at each step ($n = 114$)

* p -value is based on partial F -test.

GOHAI, General Oral Health Assessment Index; MMSE, mini-mental state examination; CHF, congestive heart failure; SSQ-SF, Social Support Questionnaire-Short Form; GDS, Geriatric Depression Scale.

Unfortunately, only 22% of cases characterized as major depression are diagnosed and receive adequate treatment (Hirschfeld *et al.* 1997). A mounting body of work has identified management of depressive symptoms as one of the future key areas in the health of older people. Nurses have intimate and ongoing contact with older patients and therefore are best positioned to screen for depressive symptoms and referring high-risk older people to care. Routine screening for depressive symptoms should be reinforced given that many effective treatments exist for older people with depressive symptoms and its strong link with malnutrition and other related disabilities.

Functional status measured by BI has emerged as another important predictor after multiple adjustments in our study. Functional status, a cardinal component of the care of older people has been identified in many studies as an important predictor to malnutrition in older people (Unosson *et al.* 1991, Chen 2005). The importance of identifying impairments of functional status lies in the fact that they may be amenable to intervention. Prior studies using specialized geriatric units or geriatric consultation services have demonstrated promising effects in improving functional status of older patients during their hospitalization (Thomas 2002). Many nursing interventions including feeding assistance, mobilizing plan for patients, daily visit/orientation protocol and making environmental modifications, have been the essential components of these successes (Wanich *et al.* 1992, Inouye *et al.* 2000). Studies are warranted to test the effectiveness of these hospital-based nursing interventions in improving nutritional status and related outcomes in the hospitalized older people.

Although cumulative research points to a robust association between SES (income and education in particular) and health, the magnitude of the effect of SES on health seems to vary across social groups. For example, a weaker socioeconomic gradient in health and mortality has been observed for retired elders and women (Beckett 2000, Duncan *et al.* 2002). In our study, income and education were not significantly related to nutritional status. Only gender remained significant in the final regression model, in which the nutritional status of female subjects was slightly worse than that of males, after multiple adjustments. Gender difference has been observed in the nutrition literature in terms of food preference, intake pattern and risk profile for malnutrition (Bates *et al.* 1999, Quandt & Chao 2000, Locher *et al.* 2005). There are two possibilities for this observed gender difference. First, females are biologically different from males and are more susceptible to poor nutritional status. Studies have suggested that a number of fundamental metabolic differences existed between older males and females (Bates *et al.* 1999, Dionne

et al. 1999). Secondly, the interaction effects of age, education with income and/or other predictors like social support or depressive symptoms might be more complicated for women (Castel *et al.* 2006). For example, gender differences have been reported in the exposure and reactivity to stressors and social support, giving rise to the assumption that the pathogenic and interactive effect of these factors is different in males and females (Hops 1996). Therefore, the possibility of gender serving as an adjusting factor in our model cannot be excluded. Given the limited sample size of our study, such interaction effects cannot be tested. Future study with diverse sample profiles might want to investigate on these hypotheses.

Polypharmacy, defined as the number of medications taken, emerged as a significant predictor of nutritional status in our study. This finding is consistent with the Belgian study, in which Griep *et al.* (2000) studied nutritional status in a group of retirement home-living older people and found that number of medications contributed negatively to the MNA scores. Another larger cohort study has reported that a great number of medications were associated with increased risk of weight loss in older people (>4.54 kg in a year), after extensive adjustment for age, visual impairment, comorbidities, cognitive impairment and depressive symptoms (Agostini *et al.* 2004). Similarly, the relationship between number of medications taken and MNA nutritional status was consistent and remained after extensive adjustment in our study. Present medication prescribing is predicated on the disease-specific benefits and individual adverse effects. Our study finding suggests that more careful consideration should be directed toward the compromises between the benefits and harms of total medication consumption in older patients.

The study has limitations. First, the sample size is small and data were collected at one site so the generalizability is limited. Secondly, the possibility of undetected confounders cannot be excluded. Furthermore, although many comorbidities have been considered, information on all chronic illness and severity of illness were not available. Nevertheless, the relationship between functional status, number of medications taken, depressive symptoms and MNA nutritional status was fairly consistent and remained after extensive adjustment. These results mandate heightened attention to these prevalent geriatric issues, namely polypharmacy, depressive symptoms, compromised ADL functional status and their impact on nutrition and related disability. A mounting body of work suggests that malnutrition or weight loss is one of most important contributors to frailty, which has important implications for both prevention and treatment (Walston 2004). In agreement with our study, these findings

emphasize the importance of timely recognition of high-risk older people who seem to be on the edge of falling into the cascade of illness and frailty.

Conclusion

The results of this study have allowed the research team to scrutinize the sub-element concepts and empirical indicators of the framework presented in 2001. The changes made represent the results of an up-to-date literature review and an empirical testing about what antecedes the development of malnutrition in hospitalized older people. It is, therefore, the detail of the framework that has been further refined. The refined framework now reflects a critical synthesis of the literature and is more distinct than the original that was first proposed. Although some of the contents have been refined, the basic proposition of it remains the same. Malnutrition in older people is a multi-dimensional concept encompassing physical, psychosocial and cultural elements. It is worth noting that although the original concept analysis was based mostly on western literature, the resulting framework appears to be appropriate for empirical use in Taiwan. Risk profile is fairly similar across regions. Given that malnutrition in older people is significant globally, a framework like this will have international implications for guiding nurses in designing or implementing hospital-based screening or intervention programmes.

This process of revisiting the concept of malnutrition in older people has highlighted that more needs to be understood about the links outside of these individual factors affecting nutrition in older people, given that only 48.2% of the variance was explained by these individual factors. For example, the way in which biology and individual and social action interact needs to be studied further. The importance of construct of loss, although it is heavily emphasized in the literature, needs to be studied further given its minimal prediction on nutrition after other constructs being added. It would be premature to suggest that this refined framework represents a final version. Research is currently underway to validate and refine the framework further. This phase will provide a larger, longitudinal dataset to ensure that the framework is not just comprehensive and generalizable but also relevant to healthcare providers who are implementing evidence-based practice.

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Contributions

Study design: CC, ST; data collection and analysis: CC, YB, GH and manuscript preparation: CC, YB, GH, ST.

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