Advances in Nursing Science
Vol. 28, No. 4, pp. 376–389

Dynamics of Nutritional Health in a Community Sample of American Elders

A Multidimensional Approach Using Roy Adaptation Model

Cheryl Chia-Hui Chen, DNSc, GNP; Chin-Kuo Chang, PhD; Deborah A. Chyun, PhD, RN, FAHA; Ruth McCorkle, PhD, FAAN

Nutritional health of community-dwelling elders has been shown to be one of the prime indices of health, influencing the elders' ability to live independently. However, little research has been directed toward understanding the dynamics of nutritional health in community-dwelling elders using a multidimensional theory approach. The purpose of this study was to evaluate the dynamics of nutritional health within the context of Roy Adaptation Model. Factors associated with nutritional health of community-dwelling elders were cross-examined. Depressive symptoms, functional status, oral health, and income emerged as independent predictors of nutritional health adjusting for confounders. This finding lends support to the notion that multidimensional biopsychosocial factors contribute to the dynamics of nutritional health. **Key words:** *aged*, *malnutrition*, *nutritional status*, *oral health*, *Roy Adaptation Model*

ENSURING adequate nutritional health for the elders has been shown to reduce healthcare costs and enhance quality of life.[1] However, few studies are aimed at a multidimensional theory-guided evaluation of nutritional health. Significant gaps exist in our understanding of dynamics of nutritional health, particularly in community-dwelling elders. Horwath reviewed more than 90 studies related to the nutritional health and concluded that the majority of studies were conducted in small, highly selected samples with limited generalizability.[2] On the basis of these findings, a lengthy list of interacting age-related, cultural, and biopsychosocial factors is included in Morley's *MEALS ON WHEELS* mnemonic or Robbins's *9 Ds* for the causes of weight loss.[3,4] A limited consensus, however, exists in the literature regarding the relative importance of these factors.[5] Researchers have largely ignored the fact that factors involved with nutritional health were highly correlated. Failure to take these confounding effects into account distorts the relationship of these factors, given their high correlation.

Fragmentation of studies on associated factors and lack of empirical validation of

From the National Taiwan University School of Nursing & National Taiwan University Hospital, Taipei (Dr Chen); Chinese University of Hong Kong (Dr Chang); and Center for Excellence in Chronic Illness Care (Dr McCorkle) and Yale University School of Nursing (Dr Chyun), New Haven, Conn.

This study was supported by NINR/NIH grant F31NR08073, awarded to Dr Chen. The authors acknowledge Drs Mary Tinetti, George Knafl, and Judith Wylie-Rosett for their invaluable assistance with the original work. Special thanks go to Dr David T. Chen, DDS, for his help on oral health assessment training and Ms Noella Rhone and Ophelia Empleo-Frazier for their assistance with data collection.

Corresponding author: Cheryl Chia-Hui Chen, DNSc, GNP, National Taiwan University School of Nursing, 1, Jen-Ai Rd, Section 1, Taipei 100, Taiwan (e-mail: cheryl.chen@ha.mc.ntu.edu.tw).

predictive models in nutritional health of community-dwelling elders hampers progress in this area. A proliferation of lengthy lists of factors associated with nutritional health places a barrier on the development of targeted interventions for preventing and treating malnutrition. Of note, nutritional health is a continuum with malnutrition at one of the continuum and being well-nourished at the other. The terms *malnutrition* and *undernutrition* tend to be used interchangeably in the literature. Although there are health consequences of nutritional excesses for the aged, this study focused on the issues of undernutrition, because it is now a documented area of concern in older populations.[6]

The purpose of this study was to evaluate the dynamics of nutritional health by testing the relative importance of most cited factors including demographics, comorbidities, medication use, functional status, oral health, presence of social support, loneliness, and depressive symptoms in predicting nutritional health in a sample of community-dwelling elders, using the Roy Adaptation Model (RAM) as a guide for a multidimensional approach. The use of hierarchical regression adds to the literature by revealing the separate effects of each factor on nutritional health.[7] The final model was able to control for both demographic and comorbidity effects in determining the relative importance of biopsychosocial factors on nutritional health.

THEORETICAL FRAMEWORK

A theoretical framework provides a distinctive frame of reference and a coherent way of thinking, observing, and interpreting phenomena, and each model provides a unique focus to understand certain aspects of reality.[8] The RAM was used as a theoretical framework for studying nutritional health, given its suitability in terms of involved conceptual domains and potential applications.[9] Figure 1 outlines the conceptualization, research structure, and selection of variables in this study. The RAM depicts humans as biopsychosocial beings who are required to adapt to environmental stimuli. Problems arise when the person's adaptive system is unable to cope with constantly changing stimuli from the environment in a manner that maintains the integrity of a system. Environmental stimuli include the focal (stimuli immediately confronting individuals) and contextual (contributing factors in a given situation) stimuli that confront individuals. The behaviors that result from the coping processes can be observed in 4 biopsychosocial response modes including (1) physiological; (2) self-concept; (3) role function; and (4) interdependence to serve as a framework for assessment. Biopsychosocial responses in any one mode may act as stimuli for further input into the system. Human health is a function of input stimuli and the individual adaptation level.[8] Nutritional health, therefore, is conceptualized as an important aspect of the adaptation level. According to the propositions of RAM and an exhaustive literature synthesis, environmental focal stimuli were postulated to include numbers of comorbidities and medications and demographic factors were hypothesized as the contextual stimuli. Biopsychosocial responses that could be observed from 4 interrelated modes were hypothesized to include oral health, depressive symptoms, social support, loneliness, and functional status.[7,9–12] The detailed process of conceptualization and the model testing has been published elsewhere.[13]

DESIGN

A cross-sectional community-based survey was conducted. A trained geriatric nurse practitioner, who used structured instruments to obtain information and measures on demographics, comorbidities, medication, functional status, oral health, social support, loneliness, depressive symptoms, and nutritional health, collected data prospectively. All subjects were interviewed in their homes, received anthropometric measures including weight, knee height, mid-arm and calf

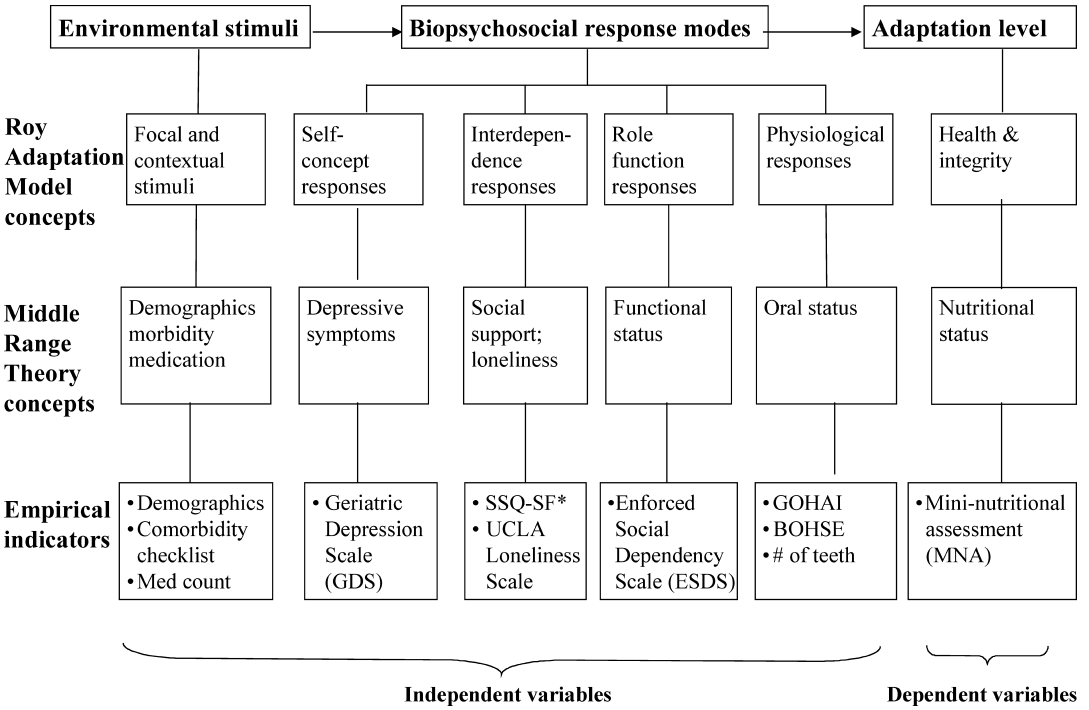

Figure 1. The RAM-based conceptual-theoretical-empirical structure of nutritional health of community-dwelling elders in this study ($n = 240$). SSQ-SF indicates Social Support Questionnaire Shord Form; GOHAI, Geriatric Oral Health Assessment Index; and BOHSE, Brief Oral Health Status Examination.

circumference, and underwent a brief oral health examination.

MEASURES WITHIN EACH CONCEPTUAL DOMAIN

Environmental contextual and focal stimuli

Demographics collected in the interview included age, gender, marital status, ethnicity, education, living arrangement, income levels, and religion. Among these, age and indicators of socioeconomic status have been suggested to strongly associate with nutritional health.[11,14] The self-reported Co-morbidity Checklist was used to assess the presence of 14 chronic illnesses, including myocardial infarction, angina, heart failures, other heart disease, hypertension, diabetes, arthritis, stroke, lung disease, vision problems, hearing problems, Parkinson's disease, hip fracture, and cancer.[15] Medication use was assessed by a medication count. Subjects were asked whether, currently, they were taking medications prescribed by a provider or any other medications obtained from a store and, if so, they were asked to show the interviewer all these medications. Validity and reliability were ensured by a standardized protocol. Both medication use and comorbidities were treated as continuous variables in the analysis.

Biopsychosocial responses

Oral health was measured by a counting of the remaining natural teeth, examiner-rated Brief Oral Health State Examination (BOHSE), and the self-reported Geriatric Oral Health Assessment Index (GOHAI). The number of natural teeth has been used as a proxy for oral health.[16] The BOHSE was used to check on 10 items (3 descriptors) that reflected the status of oral health. The sum scores range

from 0 (*healthy*) to 20 (*very unhealthy*). Satisfactory test-retest ($r = 0.83–0.79$) and interrater reliability ($r = 0.68–0.40$) have been reported, and content validity was established by 6 field experts.[17] The 12-item GOHAI (each with 3 descriptors) was used to assess the dimensions of function (eating and speaking), pain, discomfort, worry, and social functioning of subjects' oral health over the last month. The sum scores range from 12 to 36 with a high value indicating better perceived oral health. Construct validity was demonstrated by the association with clinical dental status and satisfaction reliability (Cronbach's $\alpha = .83–.79$; interrater reliability = 0.61) has been reported.[18]

Depressive symptoms over the last month were measured by the 30-item self-report, dichotomized Geriatric Depression Scale (GDS). The GDS is 84% sensitive and 95% specific for diagnosing depression in the elderly, using a cutoff score of 11 and above.[19] The sum scores range from 0 to 30 and were used for analysis. Social support was measured by the 6-item Social Support Questionnaire—Short Form (SSQSF). In 6 common situations, subjects were asked to list up to 9 people who could be counted on and specified overall degree of satisfaction over the last month. The coefficient α ranged from .90 to .93 and construct validity has been supported by the fact that SSQ scores related negatively to loneliness, depression, and low self-steem.[20] The sum scores range from 6 to 90 with higher score indicating higher degree of social support. Loneliness over the last month was measured by the 20-item Likert-style University of California at Los Angles Loneliness Scale (with 4 descriptors). Internal consistency (coefficient α of .94) and test-retest reliability over 1 year ($r = 0.73$) have been reported. The construct validity was supported by significant relations with measures of the individual's interpersonal relationships.[21] The sum scores range from 20 to 80 with higher scores indicating a higher degree of perceived loneliness.

Functional status was measured by the 10-item, observer-rated Enforced Social Dependency Scale (ESDS). The ESDS measures physical (eating, dressing, walking, traveling, bathing, and toileting) and social competence (home, work, recreational activities, and communication).[22] The sum scores range from 10 to 51, with higher scores reflecting worse functional status. Satisfaction reliability estimates (Cronbach's $\alpha = .78–.96$; test-retest $r = 0.62$) have been reported and concurrent and predictive validity have been supported by the correlation with other functional assessments and its prediction to survival.[23]

Nutritional health was measured by the 18-item, observer-rated Mini-Nutritional Assessment (MNA). The sum scores could be used either as continuous or categorical variables. Scoring fewer than 17 is regarded as undernourished, 23.5–17 were at risk, and more than 24 were considered well-nourished (out of a maximum of 30). A 96% sensitivity, 98% specificity, and satisfactory interrater reliability (κ coefficient = 0.65–0.42) have been reported.[24] In addition, weight loss history was obtained and body mass index (BMI) was calculated with self-report maximal height and measured weight (to the nearest 0.1 kg).[25] The reason for using self-report maximal height was due to the argument in the literature suggesting that BMI might be inflated when using current measured height, given that the loss of height is common in old age. The true BMI can be calculated only by using original, premorbid height reflecting the true length of the body frame.[26]

METHODS AND PROCEDURES

A population-based sample was recruited. The study population was defined as 310 senior residents who lived in an inner-city public housing complex in southern Connecticut. The facility was independent living in nature and approximately one third of the residents were subsidized by public funds. The study protocol was approved by the Institutional Review Board at Yale School of Nursing. Every resident was invited to participate by letter and this was followed with personal

contact. Subjects were not recruited if they were younger than 60 years ($n = 3$), were unable to sign a consent form ($n = 5$), were hospitalized ($n = 7$), did not speak English ($n = 26$), or were unable to be located despite multiple attempts ($n = 7$). Consent by proxy was not used in this study because of both its methodological and ethical problems. Of 262 eligible subjects, 240 subjects were recruited and assessed from June to December 2002. The participation rate was 91.6%. The nonparticipants ($n = 22$) did not differ significantly from the participants in gender ($P = .23$), age ($P = .38$), ethnicity ($P = .74$), living arrangement ($P = .14$), or marital status ($P = .98$). The reasons for nonparticipation included being too busy ($n = 8$), not interested ($n = 6$), not feeling well ($n = 6$), and privacy protection ($n = 2$). Table 1 provides a glance of the study sample and detailed sample description has been reported elsewhere.[13]

ANALYSIS OF DATA

Data were analyzed using SPSS, version 11 (SPSS, Inc, Chicago, Ill). Data were reviewed and double entered to assure accuracy. Because the number of undernourished subjects (MNA < 17) was small, subjects were regrouped as well-nourished (MNA ≥ 24) or not well-nourished (MNA < 24) as the dependent variable for analyses. Although nutritional health should be viewed as a continuum and using a dichotomized coding seems to contradict that conceptualization, a tradeoff decision was made to apply logistical regression for the following reasons. First, there are certain clinical conditions that need a clear differentiation of subjects to effectively mange risk within the given resources. Linear relationship (as using continue scores for nutritional health) might not satisfy this need of stratification. Second, scoring 24 and below in MNA has been associated with worse patient outcomes and researchers have used 24 as a cutoff point in many studies.[27–29] Last but not least, a multiple regression was applied prior to logistic regression to test if different predictors will emerge; the findings indicated that both models generated almost identical sets of predictors.[30] Therefore, hierarchical logistic regression was chosen as the final method for its better stratification of risk, understandability for most clinicians, and its capacity to reveal the separate effects of each factor on nutritional health.

Unadjusted odd ratios of each factor to low MNA (<24) versus high MNA (≥24) scores were first computed. The factors associated with low MNA scores at $P < .25$ were then considered in multivariate modeling. Since 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. Hierarchical logistic regression was applied, guided by the theoretical sequence of RAM (see Fig 1, from left to right), to examine separate effects of each factor on low MNA scores. Only variables with the best predictive capacity were contained in the final model. A variety of models were examined to rule out order effects prior to specification of the final model. Significance was set at $P < .05$.

FINDINGS

The sample was predominately female (78.3%), well-educated (70.5% had 12 years and above of schooling), and of diverse income and ethnic backgrounds (30.8% were minority), as shown in Table 1. Ages ranged from 61 to 98 years with a mean of 81.7 years and standard deviation (SD) of 8.7 years. Forty percent of subjects ($n = 96$) were aged 85 years and older with 48 subjects (20.0%) in their 90s. The BMI ranged from 14.5 to 49.8 kg/m^2 with a mean of 25.5 and SD of 6.5. Using the criteria recommended by the Nutrition Screening Initiative,[31] 81 subjects (33.8%) had a BMI less than 22 kg/m^2 and therefore were classified as underweight. Conversely, 85 subjects (35.4%) having a BMI more than 27 kg/m^2 were considered overweight. In terms of MNA scores, 13 subjects (5.4%) scored less than 17 and were classified

Table 1. Logistic analysis of factors associated with low Mini-Nutritional Assessment (MNA) scores ($N = 240$)

Associating factors, %	Number MNA < 24	Number MNA ≥ 24	Crude odds ratio (95% CI)	*P*
Age group				
60–74 y (21.2%)	15	36	ref (–)*	
75–84 y (38.8%)	40	53	1.81 (0.87–3.75)	.223
85 y and older (40.0%)	51	45	2.72 (1.32–5.61)	.009†
Gender				
Male (21.7%)	14	38	ref (–)*	
Female (78.3%)	92	96	2.60 (1.32–5.12)	.006†
Ethnicity				
White (69.1%)	77	89	ref (–)*	
Black (27.1%)	24	41	0.68 (0.38–1.22)	.194
Others (3.8%)	5	4	1.45 (0.38–5.57)	.593
Marital status				
Widowed (66.3%)	76	83	ref (–)*	
Married (7.9%)	5	14	0.39 (0.13–1.14)	.084
Divorced (16.2%)	13	26	0.55 (0.26–1.14)	.107
Single (9.6%)	12	11	1.19 (0.50–2.86)	.695
Education, y				
8 or less (13.3%)	14	18	ref (–)*	
9 or more (86.7%)	92	116	1.02 (0.48–2.16)	.959
Annual income				
Less than 10,000 (37.1%)	50	39	ref (–)*	
10,001 or more (47.1%)	34	79	0.34 (0.19–0.60)	<.001†
No idea/refuse to answer (15.8%)	22	16	1.07 (0.50–2.31)	.850
Religion				
Protestant (30.4%)	30	43	ref (–)*	
Catholic (11.2%)	7	20	0.50 (0.19–1.34)	.167
Jewish (56.3%)	66	69	1.37 (0.77–2.44)	.283
Others (2.1%)	3	2	2.15 (0.34–13.66)	.417
Hypertension				
No (25.4%)	34	27	ref (–)*	
Yes (74.6%)	72	107	0.53 (0.30–0.96)	.036†
Diabetes mellitus				
No (42.1%)	89	99	ref (–)*	
Yes (57.9%)	17	35	0.54 (0.28–1.03)	.062
Total morbidities				
0–4 (36.7%)	37	51	ref (–)*	
5–15 (63.3%)	69	83	1.15 (0.67–1.95)	.615
Number of medications				
0–3 (29.1%)	29	34	ref (–)*	
4–6 (42.9%)	40	63	0.74 (0.40–1.40)	.362
7–17 (28.0%)	37	37	1.17 (0.60–2.30)	.643
Depressive symptoms				
GDS ≤ 11 (83.3%)	76	124	ref (–)*	
GDS > 11 (16.7%)	30	10	4.90 (2.27–10.58)	<.001†

(*continues*)

Table 1. Logistic analysis of factors associated with low Mini-Nutritional Assessment (MNA) scores ($N = 240$) (*Continued*)

Associating factors, %	Number		Crude odds ratio (95% CI)	*P*
	MNA < 24	MNA ≥ 24		
Social support				
SSQSF = 6–42 (35.8%)	56	30	ref (–)*	
SSQSF = 43–49 (30.8%)	30	44	0.37 (0.19–0.69)	.002†
SSQSF = 50–90 (33.4%)	20	60	0.18 (0.09–0.35)	<.001†
Loneliness				
UCLA-LS = 20–29 (34.6%)	29	54	ref (–)*	
UCLA-LS = 30–41 (33.8%)	33	48	1.28 (0.68–2.41)	.444
UCLA-LS = 42–80 (31.6%)	44	32	2.56 (1.34–4.86)	.004†
Functional status (ESDS)				
ESDS = 10–15 (32.1%)	15	62	ref (–)*	
ESDS = 16–24 (35.8%)	42	44	3.95 (1.95–7.98)	<.001†
ESDS = 25–51 (32.1%)	49	28	7.23 (3.48–15.02)	<.001†
Self-perceived oral health				
GOHAI = 12–32 (32.5%)	48	30	ref (–)*	
GOHAI = 33–35 (32.1%)	28	49	0.36 (0.19–0.69)	.002†
GOHAI = 36 (35.4%)	30	55	0.34 (0.18–0.65)	.001†
Examiner-rated oral health				
BOHSE = 0–1 (32.9%)	29	50	ref (–)*	
BOHSE = 2 (26.7%)	27	37	1.26 (0.64–2.47)	.505
BOHSE = 3–9 (40.4%)	50	47	1.83 (1.00–3.36)	.050†

*ref (–) indicates the group was used as a reference group for analysis.
†Statistical significance.

as undernourished, and 93 subjects (38.8%) scored 17 to 24 and were at risk of undernutrition; the remaining 134 (55.8%) were considered well-nourished. Detailed nutritional scoring is provided in Table 2.

Categorical analyses were computed, as shown in Table 1, to provide an easy-to-read table showing preliminary relationships among variables. Factors associated with nutritional health were grouped for maximizing statistical power by combining categories with few observations. Subjects were grouped as well-nourished (MNA ≥ 24; $n = 134$; 55.8%) and not well-nourished (MNA < 24; $n = 106$; 44.2%) for the binary outcome in logistic regression. Compared to men, women had a 2.6-fold higher risk of low MNA scores, with 95% CI of 1.32–5.12. Depressive symptoms were a strong predictor with OR = 4.90 (95% CI: 2.27–10.58). Age group, loneliness, functional status, and examiner-rated oral health (BOHSE) revealed strong associations with low MNA scores. Meanwhile, annual income more than $10K, history of hypertension, presence of social support, and better perceived oral health (GOHAI) appeared to be preventive for low MNA scores.

To build the initial full model, age, gender, ethnicity, religion, income levels, having hypertension, having diabetes, numbers of morbidities, number of medications, scores of the GDS, SSQSF, loneliness scale, ESDS, GOHAI, BOHSE, and number of teeth were forced into the model, to predict low MNA scores. Except gender, ethnicity, religion, income levels, and history of hypertension or diabetes, all other factors were treated as continuous variables in model building. As shown in Figure 1, the order of variables being entered was decided as the contextual stimuli (age, gender, income, ethnicity, and religion), focal stimuli (history of hypertension or

Table 2. Details of Mini-Nutritional Assessment (MNA) items for study subjects ($N = 240$)*

Variables	Mean	SD, %
BMI		
BMI < 19	33	13.8
19 ≤ BMI < 21	28	11.7
21 ≤ BMI < 23	35	14.6
BMI > 23	143	59.6
MAC, cm		
MAC < 21	2	0.8
21 ≤ MAC < 22	4	1.7
MAC ≥ 22	234	97.5
CC, cm		
CC < 31	45	18.8
CC ≥ 31	195	81.3
Weight loss during last month		
> 3 kg	9	3.8
Does not know	25	10.4
Between 1 and 3 kg	76	31.7
No loss	130	54.2
Lives independently (no nursing home/hospital)		
No	2	0.8
Yes	238	99.2
Takes > 3 prescriptions per day		
Yes	169	70.4
No	71	29.6
Psychological stress/past 3 months		
Yes	69	28.8
No	171	71.3
Mobility		
Bed or chair bound	0	0.0
Able to get out of bed/chair but does not	23	9.6
Goes out	217	90.4
Neuropsychological problems		
Severe dementia or depression	1	0.4
Mild dementia	42	17.5
No psychological problems	197	82.1
Pressure sores or skin ulcers		
Yes	6	2.5
No	234	97.5
Number of full meals daily		
1 meal	4	1.7
2 meals	81	33.8
3 meals	155	64.6
Consumption markers for protein intake		
0 or 1 yes†	27	11.3
2 yes†	113	47.1
3 yes†	100	41.7
Two or more servings of fruits or vegetables per day		
Yes	118	49.2
No	122	50.8

(*continues*)

Table 2. Details of Mini-Nutritional Assessment (MNA) items for study subjects ($N = 240$)* (*Continued*)

Variables	Mean	SD, %
Intake decline over past 3 months		
Severe loss of appetite	1	0.4
Moderate loss of appetite	59	24.6
No loss of appetite	180	75.0
Consumed fluid per day		
Less than 3 cups	2	0.8
3 to 5 cups	109	46.3
More than 5 cups	127	52.9
Mode of feeding		
Unable to eat without assistance	0	0.0
Self-fed with some difficulty	10	4.2
Self-fed without any problem	230	95.8
Self-view of nutrition status		
View self as being malnourished	2	0.8
Uncertain of nutritional state	54	22.5
View self as having no nutritional problem	184	76.7
Self-view of health status comparing with others		
Not as good	7	2.9
Does not know	30	12.5
As good	99	41.3
Better	104	43.3
Total (MNA score, maximum 30 points)	24.10	3.41
Undernutrition indicator score		
Malnourished (MNA < 17)	13	5.4
At risk of malnutrition ($17 \leq$ MNA ≤ 23.5)	93	38.8
Not at risk (MNA ≥ 24)	134	55.8

*BMI indicates body mass index; MAC, mid-arm circumference; and CC, calf circumference.
†Numbers of yes to the followings; ≥1 serving of dairy product per day; ≥2 servings of egg or legumes; meat, fish, or poultry every day.

diabetes, numbers of comorbidities, and medications), and biopsychosocial responses (GDS, SSQSF, loneliness, ESDS, GOHAI, BOHSE, and teeth). The reason for entering contextual ahead of focal stimuli was due to the irreversibility of these contextual variables in reality. In addition, given the strong suspicion in the literature regarding the interacting effects of disease and nutrition, the focal stimuli (number of comorbidities and medications) were forced into the model as a proxy for disease-related impact. The initial full model presented a good fit with −2 log likelihood value of 236.09. After testing several potential models to rule out order effects, a parsimonious model was developed, which included age, gender, ethnicity, income levels, number of comorbidities and medications, depressive symptoms, social support, functional status, and self-perceived oral health (GOHAI), respectively, with −2 log likelihood value of 248.86. Hosmer-Lemeshow test was applied to examine the goodness-of-fit of models and indicated a good fit. Final model statistics are shown in Table 3.

CONCLUSION

This study provided an exploratory test of the most cited factors associated with

Table 3. The final hierarchical model—Factors associated with low Mini-Nutritional Assessment (MNA) scores (<24)

Associating factors	Adjusted odds ratio (95% CI)	*P*
Age	1.00 (0.96–1.04)	.929
Gender		
Male	ref (–)*	
Female	2.14 (0.91–5.02)	.082
Ethnicity		
White	ref (–)*	
Black	0.81 (0.35–1.88)	.631
Others	1.63 (0.33–8.09)	.551
Annual income		
Less than 10,000 (37.1%)	ref (–)*	
10,001 or more (47.1%)	0.40 (0.19–0.84)	.014†
No idea/refuse to answer (15.8%)	1.01 (0.39–2.65)	.982
Total morbidities	0.99 (0.78–1.25)	.905
Number of medications	0.96 (0.84–1.09)	.509
Depressive symptoms (GDS)	1.12 (1.03–1.21)	.008†
Social support (SSQSF)	0.98 (0.94–1.01)	.221
Functional status (ESDS)	1.09 (1.03–1.15)	.005†
Self-perceived oral health (GOHAI)	0.87 (0.78–0.97)	.009†

*ref (–) indicates the group was used as a reference group for analysis.
†Statistical significance. Hosmer-Lemeshow test: $\chi^2 = 8.90$, $df = 8$, $P = .35$.

nutritional health in community-dwelling elders. The strength and independent effects of these associations were examined and demonstrated through hierarchical regression. When the combined influence of potential confounders was controlled for (including age, gender, ethnicity, number of comorbidities and medications, and social support), the presences of depressive symptoms, oral health problems, lower functional status, and income less than $10K emerged as independent predictors of undernutrition (MNA < 24), a compromised nutritional health. These factors may assist care providers in identifying elderly subjects at high risk for undernutrition.

This study is consistent with previous work showing that depressive symptoms were strongly associated with undernutrition. Wilson conducted a nutrition survey with 1017 American outpatients and found that depression was the most common cause of undernutrition in older outpatients, occurring in 30% of undernourished group.[32] Visvanathan evaluated 250 Australian domiciliary care recipients (mean age 79.7 with SD of 6.8) and found that higher GDS scores were strongly associated with low MNA scores (OR = 1.04 with 95% CI of 1.03–1.05).[28] Thomas evaluated 837 older patients admitted to a subacute center and found that GDS scores were also significantly higher in the undernourished subjects (MNA < 17).[33] Using a stringent model building procedure, depressive symptoms remained predictive of low MNA scores in the present study. Conversely, despite showing strong associations in preliminary analyses, social support and loneliness did not remain predictive in the final model. Previous research has not fully explored the impact of these factors. It is conceivable that depressive symptoms may have confounded the relationship of loneliness and social support and that once depressive symptoms were accounted for, these factors did not remain important.

Functional status measured by ESDS demonstrated its predictive power in relation

to MNA scores. The mean ESDS score of 20.25 appeared to be on the lower end of reference values consistent with the functional status among ambulatory elders. However, differences in measurement methods make direct comparison of studies difficult. Two pervious community-based studies have indicated that physical and mental scores of the Short Form Health Survey (SF-36) were independent predictors of low MNA scores.[28,34] Activities of daily living (ADLs) function were also found to be predictive of nutritional health in a number of previous studies.[35,36] Therefore, regardless of what measure was used, functional status is likely to be a cardinal factor related to nutrition and health in general. Prior research has demonstrated the effectiveness of some community-based interventions in improving functional status, retaining elders at home, and maximizing patient outcomes.[37] Studies are warranted to test the effectiveness of these interventions in improving nutritional health of community-dwelling elders.

In contrast, few relationships between oral health and nutrition have been observed in the literature. The relationship between specific oral health indicators (eg, number of natural teeth, masticatory ability, or wearing denture) and nutritional health often diminished in multivariate analysis.[12,34,38,39] Similarly, the number of natural teeth or examiner-rated BOHSE did not show a strong association in this sample, but self-perceived oral health (GOHAI) appears to be predictive of low MNA scores even after controlling for other factors. This finding supports not only the importance of self-perceived oral health on nutritional health but also the utilization of GOHAI in screening and planning care for community-dwelling elders.

The number of medications taken did not show strong association with nutritional health in this study. This finding is in contrast to a Belgian study, which found that the number of medications contributed negatively to the MNA scores ($\beta = -.31$, $P = .008$).[34] The impact of medication use appears to be nonconclusive from the current data. Nevertheless, the high prevalence of polypharmacy in this and other samples of elders is alarming.[40,41]

Although cumulative research points to a robust association between socioeconomic status (income and education in particular) and health, the magnitude of the effect of socioeconomic status 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.[42,43] In this study, gender, ethnicity, and education were not significantly related to nutritional health, after controlling for confounders. Only income more than 10K per year remained significantly protective to nutritional health in the final model. Therefore, income may still be a reasonable proxy reflecting available financial resources in community-dwelling elders and earning more than 10K a year reduced the chance of having compromised nutritional health. However, income may be a product of recent and past health and/or a representation of the cumulative effects of lifetime of deprivation or privilege, associations between income and nutritional health may subject to reverse-causation and needs further investigation. It is worth noting that central to the feminist and critical social theory is the emphasis on the social contraction of reality and on sociopolitical and economic influences on science.[44,45] Researchers across disciplines are shifting their views on health to an ecological focus to view individual health within the context of sociopolitical and economic environment. Nursing profession must incorporate these relevant domains, including biology as well as individual and social action, and specify the hypothesized links with reality to study the dynamics of physiological health.

Despite a careful design, this study had limitations. The sample was confined to one site with high percentages of female and Jewish subjects, so the generalizability was limited to these elders. Further, the study was cross-sectional, so the relationships shown were

more correlational than causal. One of the strong points of the study is the fact that the study sample included a large number of oldest-old (40% were ≥85 years), which helps inform the care for this fastest growing subpopulation in the United States. Second, the sample size of 240 in a post hoc analysis revealed that the power was 0.98. This level of power enhanced confidence to make inferences from the study results. Third, with in-depth measures on most variables, this study provides a comprehensive testing of factors associated with nutritional health, which has not been previously accomplished. The results offer compelling reasons to further investigate the significance of depressive symptoms, oral health, functional status, and income in predicting nutritional health. A mounting body of work suggests that undernutrition or weight loss is one of the most important contributors to frailty, which holds important implications for both prevention and treatment.[46–48] Specifically, the MNA was found to be predictive of higher cost of care and patient outcomes including mortality and nursing home placement.[49,50] In agreement with the current study, these findings emphasize the importance of timely recognition of high-risk elders who seem to be on the edge of a downward-spiral.

IMPLICATION FOR FUTURE RESEARCH AND NURSING PRACTICE

When asked about the self-perception of health, 8 subjects (3.3%) considered their health was "not as good" as that of other people of the same age, 30 subjects (12.4%) "did not know" if they were better or worse, 100 subjects (41.2%) reported that their health was "as good" as that of others in their age, and 105 subjects (43.2%) believed that their health was "better" than that of other people of the same age. Those numbers imply that by self-evaluation, the majority subjects felt relatively healthy for their age. However, a sizable portion of the subjects still suffered from depressive symptoms (16.9%), malnutrition (6.2% were undernourished and 38.8% were at risk by the MNA), oral health problems (38.3% were edentulous, 32.9% had chewing difficulties, and 30.6% could not swallow comfortably), and marked functional dependency (99 subjects [41.3%] had ≥3 Katz ADL limitations). Given that many of these conditions are treatable and preventable, it is important for healthcare providers to incorporate these assessments into their daily practice.

Nurses have intimate and ongoing contact with elderly patients and therefore have an opportunity and an obligation to assess and educate patients and caregivers regarding the care that promotes elders' nutritional health. More nurses without community health training will be caring for the elders in the community and frameworks such as this are needed to guide practice. Early recognition of the elders who are malnourished or at risk for such decline should prompt the introduction of an efficient work-up and the implementation of corrective nursing measures, such as meal assistance, food texture modification, depression screening, use of ADL-helping devices, or social service referral.[30]

Much of the impetus for studying the dynamics of nutritional health has emerged from the clinical observation that indicated high prevalence of undernutrition and related disabilities in a growing elderly population. This study was intended as the first step to examine the dynamics of biopsychosocial factors interacting with nutritional health. Future studies should replicate and test the application of incorporating these factors in developing targeted interventions for promoting nutritional health, an integrative part of successful aging. In terms of model fitness, the RAM has been criticized for the individualistic or even victim-blaming approach, given its conceptualization of human health as a functional of individual adaptation level. However, the multidimensional nature of RAM appears to provide a suitable and easy-to-follow frame of reference to understand certain aspect of nutritional health in this study. Namely, depressive symptoms,

functional status, oral health, and income, each represents different dimensions of the RAM and all impact on nutritional health, which further supports the validity of Roy model. Nevertheless, for future research, the goal needs to move beyond describing nutritional health and toward research that more closely examines the dynamics underlying nutritional health, including how cultural and social factors relate and how psychosocial factors may interact with biological processes longitudinally. A new paradigm is needed to recognize biopsychosocial factors as primary pathogenic forces of health.

REFERENCES

1. Institute of Medicine. *The Role of Nutrition in Maintaining Health in the Nation's Elderly*. Washington, DC: National Academia Press; 2000.
2. Horwah CC. Dietary intake studies in elderly people. *World Rev Nutr Diet*. 1989;59:1–70.
3. Morley JE, Sliver AJ. Nutritional issues in nursing home care. *Ann Intern Med*. 1995;123:850–859.
4. Robbins LJ. Evaluation of weight loss in the elderly. *Geriatrics*. 1989;44:31–37.
5. Thomas DR. Causes of protein-energy malnutrition. In: Seiler WO, Stahelin HB, eds. *Malnutrition in the Elderly*. New York: Springer; 1999:59–68.
6. Lehmann AB. Nutrition in old age: an update and questions for future research: Part I. *Rev Clin Gerontol*. 1991;1:135–145.
7. Dressler WW, Ribeiro RP, Balieiro MC, Oths KS, Dos Santos JE. Eating, drinking and being depressed: the social, cultural and psychological context of alcohol consumption and nutrition in a Brazilian community. *Soc Sci Med*. 2004;59:709–720.
8. Fawcett J. *Analysis and Evaluation of Conceptual Models of Nursing*. 3rd ed. Philadelphia: FA Davis Company; 1995.
9. Roy SC, Andrews HA. *The Roy Adaptation Model*. 2nd ed. Stamford, Conn: Appleton & Lange; 1999.
10. Chen CC-H, Schilling L, Lyder C. A concept analysis of malnutrition in the elderly. *J Adv Nurs*. 2001;36:131–142.
11. White JV. *Risk Factors Associated With Poor Nutritional Status in Older Americans*. Washington, DC: Nutrition Screening Initiative; 1991.
12. Payette H, Gray-Donald K, Cyr R, Boutier V. Predictors of dietary intake in a functionally dependent elderly population in the community. *Am J Public Health*. 1995;85:677–683.
13. Chen CC-H. A framework for studying the nutritional health in community-dwelling elders. *Nurs Res*. 2005;54:13–21.
14. Miller DK, Carter ME, Sigmund RH, et al. Nutritional risk in inner-city-dwelling older black Americans. *J Am Geriatr Soc*. 1996;44:959–962.
15. Guralnik JM. *Aging in the Eighties: The Prevalence of Comorbidity and Its Association With Disability*. Hyattsiville, Md: National Center for Health Statistics; 1989. Advance data from vital and health statistics, No. 170.
16. Gift HC, Atchison KA. Oral health, health, and health-related quality of life. *Med Care*. 1995;33:NS57–NS77.
17. Kayser-Jones J, Bird W, Paul SM, Long L, Schell ES. An instrument to assess the oral health status of nursing home residents. *Gerontologist*. 1995;35:814–824.
18. Atchison KA, Dolan TA. Development of the Geriatric Oral Health Assessment Index. *J Dent Educ*. 1990;54:680–687.
19. Yesavage JA, Brink TL, Rose TL. Development and validation of a Geriatric Depression Scale. *J Psychiatr Res*. 1983;17:31–49.
20. Sarason IG, Sarason BR, Shearin EN, Pierce GR. A brief measure of social support: practical and theoretical implications. *J Soc Pers Relat*. 1987;4:497–510.
21. Russell DW. UCLA Loneliness Scale (version 3): reliability, validity, and factor structure. *J Pers Assess*. 1996;66:20–40.
22. Benoliel JQ, McCorkle R, Young K. Development of a social dependency scale. *Res Nurs Health*. 1980;3:3–10.
23. McCorkle R, Benoliel J, Donaldson G, Georgiadou F, Moinpour C, Goodell B. A randomized clinical trial of home nursing care for lung cancer patients. *Cancer*. 1989;64:199–206.
24. Guigoz Y, Vellas B, Garry PJ. Assessing the nutritional status of the elderly: the Mini Nutritional Assessment as part of the geriatric evaluation. *Nutr Rev*. 1996;54:S59–S65.
25. Chumlea WC, Roche AF, Mukherjee D. Some anthropometric indices of body composition for elderly adults. *J Gerontol*. 1986;41:36–39.
26. Omran ML, Salem P. Diagnosing undernutrition. *Clin Geriatr Med*. 2002;18:719–736.
27. Guigoz Y, Lauque S, Vellas BJ. Identifying the elderly at risk for malnutrition: the Mini Nutritional Assessment. *Clin Geriatr Med*. 2002;18:737–757.
28. Visvanathan R, Macintosh C, Callary M, Penhall R, Horowitz M, Chapman I. The nutritional status of 250 older Australian recipients of domiciliary care services and its association with outcomes

at 12 months. *J Am Geriatr Soc*. 2003;51:1007–1011.
29. Beck AM, Ovesen L, Schroll M. Home-made oral supplement as nutritional support of old nursing home residents, who are undernourished or at risk of undernutrition based on the MNA. A pilot trial. *Aging Clin Exp Res*. 2002;14(3):212–215.
30. Chen CC-H. *Nutritional Status of Community-Dwelling Elders* [dissertation]. New Haven, Conn: Yale University; 2003.
31. National Screening Initiative. *Incorporating Nutrition Screening and Interventions Into Medical Practice*. Washington, DC: National Academia Press; 1993.
32. Wilson MMG, Vaswani S, Liu D, Morley JE, Miller DK. Prevalence and causes of undernutrition in medical outpatients. *Am J Med*. 1998;104:56–63.
33. Thomas DR, Zdrowski CD, Wilson MM, et al. Malnutrition in sub-acute care. *Am J Clin Nutr*. 2002;75:308–313.
34. Griep MI, Mets TF, Collys K, et al. Risk of malnutrition in retirement homes elderly persons measured by the Mini-Nutritional Assessment. *J Gerontol A Biol Sci Med*. 2000;55A:M57–M63.
35. Ritchie CS, Burgio KL, Locher JL, et al. Nutritional status of urban homebound older adults. *Am J Clin Nutr*. 1997;66:815–818.
36. Unosson M, Ek AC, Bjurulf P, Larsson J. Demographical, sociomedical and physical characteristics in relation to malnutrition in geriatric patients. *J Adv Nurs*. 1991;16:1406–1412.
37. Stuck AE, Egger M, Hammer A, Minder CE, Beck JC. Home visits to prevent nursing home admission and functional decline in elderly people: systematic review and meta-regression analysis. *JAMA*. 2002;287:1022–1028.
38. Appollonio I, Crabellese C, Frattola A, Trabucchi M. Influence of dental status on dietary intake and survival in community-dwelling elderly subjects. *Age Ageing*. 1997;26:445–455.
39. Fontyn-Tekamp FA, van't Hof MA, Slagter AP, van Waas MAJ. SENECA Nutrition and the Elderly in Europe. The state of dentition in relation to nutrition in elderly Europeans, in the SENECA study of 1993. *Eur J Clin Nutr*. 1996;50:S117–S122.
40. Hanlon JT, Schmader KE, Rudy CM, Weinberger M. Suboptimal prescribing in older inpatients and outpatients. *J Am Geriatr Soc*. 2001;49:200–209.
41. Ness J, Johnson D, Nisly N. Polyherbacy: herbal supplements as a form of polypharmacy in older adults. *J Gerontol A Biol Sci Med*. 2003;58:M478.
42. Duncan GJ, Daly MC, McDonough P, Williams DR. Optimal indicators of socioeconomic status for health research. *Am J Public Health*. 2002;92:1151–1157.
43. Beckett M. Converting health inequalities in later life—An artifact of mortality selection. *J Health Soc Behav*. 2000;41:106–119.
44. Gortner SR. Nursing's syntax revisited: a critique of philosophies said to influence nursing theories. Image: *J Nurs Sch.* 1990;22:101–105.
45. Boutain DM. Critical nursing scholarship: exploring critical social theory with African American studies. *Adv Nurs Sci*. 1999;21(4):37–47.
46. Walston J. Frailty: the search for underlying causes. *Sci Aging Knowl Environ*. 2004;4:pe4.
47. Liu L, Bopp MM, Roberson PK, et al. Undernutrition and risk of mortality in elderly patients within one year of hospital discharge. *J Gerontol A Biol Sci Med*. 2002;57:M741–M746.
48. Newman AB, Yaenz D, Harris T, et al. Weight change in old age and its association with mortality. *J Am Geriatr Soc.* 2001;49:1309–1318.
49. Van Nes MC, Herrmann FR, Gold G, et al. Does the Mini Nutritional Assessment predict hospitalization outcomes in older people? *Age Ageing*. 2001;30:221–226.
50. Beck AM, Ovesen L, Schroll M. A six months' prospective follow-up of 65+-y-old patients from general practice classified according to nutritional risk by the Mini Nutritional Assessment. *Eur J Clin Nutr*. 2001;55:1028–1033.