Original Article

Combined effect of eating alone and a poor nutritional status on cognitive decline among older adults in Taiwan

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Background and Objectives: Nutritional status is not only associated with older individuals' physical health but also has an impact on their cognitive functioning. Evidence indicates that a socially integrated lifestyle in the later stages of life protects against cognitive decline and dementia. This study tested the combined effect of two hazards, the risk of malnutrition and eating meals alone, on the cognitive changes among a representative sample of older Taiwanese individuals over an 8-year period. **Methods and Study Design:** Data were taken from the Taiwan Longitudinal Survey on Aging. In 1999, 2584 respondents aged ≥65 years were surveyed, and follow-up surveys were performed in 2003 and 2007. The Short Portable Mental Status Questionnaire (SPMSQ) and Mini Nutritional Assessment were used to evaluate participants' cognitive functioning and nutritional status, respectively. Nutritional status and eating alone data assessed at baseline were combined to predict changes in SPMSQ scores longitudinally. Generalized estimating equations were used to evaluate the longitudinal changes from baseline to 2007. **Results:** Findings suggest that nutritional status was a salient predictor for cognitive decline among the older Taiwanese adults over the 8-year period. Female respondents who had a compromised nutritional status at baseline and who were eating their meals alone exhibited a greater decrease in SPMSQ scores compared with those who had a normal nutritional status and who were eating their meals with others. **Conclusion:** Nutritional programs for the elderly should focus on what they eat as well as who they eat their meals with to prevent social isolation, especially among older women.

Key Words: mini nutrition assessment, cognitive functioning, eating alone, older adults, Taiwan

INTRODUCTION

Population aging has raised concerns regarding the cost and burden of caring for an increasing number of disabled older adults globally. The transformation of Taiwan's population structure in a relatively short period has been portrayed as a looming challenge[1] to both the formal and informal long-term care and healthcare systems. Among the various types of diseases and disabilities, caring for people with cognitive impairment or dementia can be both physically and emotionally challenging for their caregivers and families.[2] This might explain why approximately 50% of patients with Alzheimer's disease and related disorders are placed in a nursing home within 5 years after their diagnosis.[3]

In 2010, the number of persons with dementia was approximately 35.6 million worldwide, and this number is projected to increase to 65.7 million by 2030.[4] A survey conducted in 2013 in Taiwan reported that among people aged ≥65 years, the age-adjusted prevalence of mild cognitive impairment is approximately 18.8%, and the prevalence of all-cause dementia is approximately 8.0%, which is four times that in 1992.[5] Furthermore, dementia is the leading cause of dependency and accounts for 11.9% of the years lived with disabilities due to a

noncommunicable disease.[2] Kelly et al examined the social costs and financial risks faced by Medicare beneficiaries at 5 years before death and reported that healthcare expenditures for persons with dementia were substantially larger than those for other leading causes of death, such as heart disease or cancer.[6] The economic cost of dementia was estimated to be approximately US$ 604 billion in 2010; however, the direct medical costs contributed to just 16% of the total costs. Most of the costs were derived from informal care, such as unpaid care provided by family members.[3,6] These facts make dementia one of the top public health priorities in a rapidly aging society such as Taiwan's.

For the primary prevention of dementia and cognitive impairment, identifying modifiable risk factors for dementia is necessary. Current research has linked dementia

and cognitive functioning to the risk factors of diabetes, hypertension, obesity, and physical inactivity, which can be broadly termed as lifestyle factors; nutritional and dietary factors are the salient ones among them.[7,8]

Nutrition and cognitive functioning in old age

Older people are vulnerable to malnutrition or undernutrition, which is one of the crucial factors leading to the deterioration of health in old age. Moreover, numerous studies have reported that nutritional factors and dietary patterns are not only associated with older people's physical functioning but also with their cognitive functioning.[7] As argued by Ogawa,[8] available evidence has repeatedly demonstrated a relationship among dietary patterns, nutritional status, and cognitive functioning. The findings summarized in that review article were derived from studies with large samples of older adults, which used valid and reliable assessment tools [e.g., the Mini Nutritional Assessment (MNA)]. Furthermore, the presence of malnutrition has been linked to cognitive impairment among both hospital and community-dwelling older populations.[7,9] In addition to identifying specific nutrients that might be useful in delaying or preventing cognitive impairment and dementia, dietary patterns are deeply rooted in social and behavioural contexts. An understanding of what older people eat or what specific nutrients are related to cognitive functioning is crucial. However, knowing with whom older people eat is equally important because the social environment of a meal could also have an impact on older people's nutritional outcomes.

Studies have revealed that among community-dwelling older people, the presence of others at a meal can enhance food and calorie intake and that people who eat alone are more likely to skip meals.[10-12] A study on the energy intake of hospitalized older patients also reported that the meal social environment can influence the food intake of elderly patients.[13] Interactions with others during mealtimes can lead to longer meals and larger energy intake. A study on the nutritional self-management of older widows in rural communities discovered that widowhood was likely to result in living and eating alone. The widows interviewed in the study reported skipping more meals and less dietary variety.[14]

Eating is both a social and biological activity. When people age, their social networks and support systems shrink (e.g., becoming a widow or losing peers and friends). Meanwhile, older adults, who maintain a functional social support network, are associated with healthier dietary behaviors.[15] Consequently, among older people, eating alone seems to indicate social isolation or a lack of social support. Evidence suggests that social isolation is not only associated with poor physical health but also poor mental health and cognitive functioning among older populations.[16]

Social integration and cognitive functioning

The effects of social integration on cognitive outcomes have been documented in numerous studies.[17] A population-based study described that individuals with a greater number of social networks or higher frequency of participation in social activities were less likely to experience cognitive decline.[18] Other studies have stated that individuals with many social ties were at a decreased risk for incident cognitive decline and that social isolation accelerated cognitive decline in aging.[16,19] In a review article, Fratiglioni et al evaluated evidence from studies with longitudinal cohort and experimental designs. They concluded that an active and socially integrated lifestyle in later life protects against dementia.[20] Clearly, the associations between the measures of social integration and cognitive outcomes are consistent and strong. Older individuals who are more socially disengaged are at a greater risk of cognitive impairment.

In a society where traditional family values are much cherished, having meals together is considered a daily routine. Among the elderly in Taiwan, having meals alone could be considered a sign of a diminishing support network and social isolation, which could be detrimental to their cognitive functioning. Moreover, nutritional studies of aging have confirmed a physiological decline in food intake as people age.[10] As previously mentioned, older people who eat their meals alone are more likely to skip meals and consume less energy, making them more vulnerable to malnutrition.[12] The combined effect of a compromised nutritional status and eating alone could negatively impact the cognitive functions of elderly individuals over a period of time. In this secondary data analysis study, we test this hypothesis longitudinally over 8 years in a national representative sample of older Taiwanese individuals.

PARTICIPANTS AND METHODS
Sample

Data for this study were taken from the Taiwan Longitudinal Survey in Aging (TLSA). This panel-designed longitudinal survey was launched in 1989. A nationally representative sample of people aged ≥60 years was taken in 1989. Twenty-seven strata of approximately equal size were identified, stratified by three administrative levels (city, urban township, and rural township), three levels of education, and three levels of total fertility rate. Among the 4,412 persons selected for the survey, 4,049 responded, yielding a response rate of 91.8%. Because of the well-coordinated efforts from different government agencies and experienced interviewers, both the response rates and quality of the survey data were high. Detailed descriptions of the sampling scheme and questionnaire are provided elsewhere.[21]

Follow-up surveys were performed in 1993, 1996, 1999, 2003, and 2007. During the 1999 follow-up, nutrition-related measures were incorporated into the survey. Therefore, we included only the 1999, 2003, and 2007 follow-up survey data in the current study. Among the 4,440 surveyed participants in 1999, only those aged ≥65 years were required to complete all items on the scale, the Short Portable Mental Status Questionnaire (SPMSQ). After excluding 46 participants (1.7% of the 2630 participants aged ≥65 years in 1999) that had missing values on their SPMSQ measure, 2584 participants were available for analysis at baseline. However, by the 2003 follow-up, 517 participants had died and another three had missing values on the SPMSQ, so only 2,064 cases provided in-

formation. By the 2007 follow-up, another 492 participants had died and two had missing values on their SPMSQ, so only 1,570 cases contributed information to the current analysis.

Measures of dependent variables

The SPMSQ[22] has been used in the TLSA to measure cognitive functioning. It is a wildly used scale for assessing the mental status of older adults.[23-25] The scale contains eight item questions: "What is your home address?"; "What date is today?"; "How old are you?"; "What's your mother's surname?"; "Who is the incumbent president?"; "Who is the former president?"; "Subtract 3 from 20 for three consecutive times"; and "Repeat the five things just mentioned by the interviewer." For each correct answer, the respondent gets one point. If all questions are answered correctly (the "subtract 3 from 20" question yields three answers, accounting for 3 points), the respondent would get a score of 10. This summative score was used as the dependent variable in the following statistical analyses.

Measures of independent variables

The nutritional status was evaluated by using the MNA scale. The MNA scale is a validated and standardized screening tool developed to detect nutritional problems in older people. The scale consists of (a) anthropometric assessment, (b) general assessment, (c) dietary assessment, and (d) subjective assessment.[26] A modified version of the MNA scale, which has been tested among older Taiwanese persons, was used in the current study.[26-27] A score of <24 on the scale is considered a state of poor nutrition, indicating a protein–calorie value below the recommendation.[28] Therefore, this was used as the cut-off point to dichotomize the participants into two groups: (1) the normal nutritional status group were participants whose MNA scores were ≥24 and (2) the at risk of malnutrition or undernutrition group were respondents whose MNA scores were <24.

Eating alone data were collected by asking the respondents, "Are there others present during your meals?" An answer of "no" was coded as 1 (otherwise 0). A cross-tabulation of the dichotomous MNA scores and eating alone data yielded a four-cell combination, containing the respondents who had a normal nutritional status and were eating meals with others (the reference group), had a normal nutritional status but were eating meals alone, were at risk of malnutrition and were eating meals alone, and were at risk of malnutrition but were eating meals with others. This variable was entered into generalized estimating equation[29] (GEE) models to predict the longitudinal changes in the cognitive functioning of the surveyed elders over an 8-year period.

Other covariates included in the current study were the demographic variables, lifestyle and behavioural variables, and chronic conditions. The demographics were the older persons' chronological age and gender. Educational attainment, which was considered an important proxy for social status in Taiwanese society, was measured as years of schooling. Four chronic conditions were included as covariates to predict changes in the cognitive functioning of the elderly. In the survey, the respondents were asked, "Has a doctor ever told you that you have hypertension, diabetes, heart problems, or stroke?" For each of the four conditions, "yes" was coded as 1 (otherwise 0). Several lifestyle behaviours were also included in the current analysis. Dummy variables were created to differentiate smokers (coded as 1) from non-smokers and alcohol drinkers (coded as 1) from non-drinkers. The frequency of weekly exercise was divided into three categories (never, less than two times, and three times or more).

Finally, as a society where the norm of filial piety is emphasized, support for the elderly usually takes the form of living with families. Living arrangement was included to further evaluate the associations between social support and eating alone and their relationship with the changes in cognitive functioning. Living alone was measured by distinguishing respondents who lived alone (coded as 1) from those who lived with spouses or others (coded as 0).

Statistical analysis

When analysing longitudinal data, a major concern is accounting for correlated measurements. The GEE method, introduced by Liang and Zeger (1986),[29] is an often-used regression analysis of repeated measurement for handling the correlations among responses. The GEE method provides consistent estimators of the regression coefficients and of their variances, under weak assumptions regarding the actual correlations among participants' observations.[30] Moreover, the GEE methodology does not require complete data, which is another advantage of choosing the GEE method to analyse the data in the current study, because attrition and missing values are common in longitudinal surveys. In our GEE regression analysis, the SPMSQ scores were treated as a continuous response variable in the GEE models.

Additionally, the mean SPMSQ scores at baseline and at each of the follow-ups were calculated and plotted to illustrate the changes in cognitive functioning for the following four subgroups of older adults: (1) those who scored ≥24 on the MNA scale and had meals with others, (2) those who scored ≥24 or higher on the MNA and had meals alone, (3) those who scored <24 on the MNA scale and had meals with others, and (4) those who scored <24 and had meals alone.

RESULTS

Descriptive characteristics (percentage distributions or mean ± standard deviation) of the sample at the baseline and at the follow-up waves are shown in Table 1. The sample consisted of 2,584 older individuals aged ≥65 years (mean age, 74.0 years) at baseline. Because of sample attrition (Figure 1), by the 2003 follow-up survey, only 2,064 cases of the original 2,584 cases remained, and by the 2007 follow-up, only 1570 of them were available for analyses. At baseline, the percentage of male respondents was 54.9%. Hypertension (43.8%) was the most commonly reported disease among the female respondents, followed by heart disease (27.4%), and the same pattern was seen among their male counterparts.

Regarding the baseline distribution of the variables cross-tabulated for eating alone and at risk of malnutrition

Table 1. Distribution of sample characteristics from baseline (1999) to 2007, stratified by gender

	Baseline, 1999 (N=2,584)		Follow-up in 2003 (N=2,064)		Follow-up in 2007 (N=1,570)	
	Men	Women	Men	Women	Men	Women
Gender, N (%)	1,419 (54.9)	1,165 (45.1)	1,096 (53.1)	968 (46.9)	800 (51.0)	770 (49.0)
Hypertension, N (%)	486 (34.3)	510 (43.8)	386 (35.2)	426 (44.0)	272 (34.0)	324 (42.1)
Diabetes, N (%)	190 (13.4)	213 (18.3)	129 (11.8)	163 (16.8)	85 (10.6)	123 (16.0)
Heart disease, N (%)	275 (19.4)	319 (27.4)	207 (18.9)	255 (26.3)	146 (18.3)	197 (25.6)
Alcohol drinking, N (%)	496 (35.0)	85 (7.3)	414 (37.8)	75 (7.8)	322 (40.3)	65 (8.4)
Exercise						
Never	439 (30.9)	499 (42.8)	294 (26.8)	384 (39.7)	209 (26.1)	289 (37.5)
≤2 times/week	73 (5.1)	70 (6.0)	60 (5.5)	61 (6.30)	39 (4.9)	48 (6.2)
≥3 times/week	907 (63.9)	596 (51.2)	742 (67.7)	523 (54.0)	552 (69.0)	433 (56.2)
Living alone, N (%)	176 (12.4)	117 (10.0)	127 (11.6)	91 (9.4)	82 (10.3)	73 (9.5)
MNA score with eating alone						
<24 & eating alone, N (%)	67 (4.7)	77 (6.6)	35 (3.2)	53 (5.5)	17 (2.1)	29 (3.8)
<24 & meals with others, N (%)	166 (11.7)	153 (13.1)	96 (8.7)	113 (11.7)	59 (7.4)	81 (10.5)
≥24 & eating alone, N (%)	195 (13.7)	141 (12.1)	153 (14.0)	114 (11.8)	104 (13.0)	97 (12.6)
≥24 & meals with others, N (%)	991 (69.8)	794 (68.2)	812 (74.1)	688 (71.1)	620 (77.5)	563 (73.1)
Age, mean (SD)	73.9 (5.4)	74.2 (5.8)	73.0 (5.0)	73.4 (5.4)	72.2 (4.5)	72.7 (5.1)
Years of schooling, mean (SD)	6.2 (4.6)	2.4 (3.5)	6.5 (4.6)	2.5 (3.5)	6.8 (4.6)	2.7 (3.6)
*SPMSQ Score, mean (SD)	9.7 (2.3)	9.0 (2.9)	9.6 (0.9)	9.1 (1.3)	9.0 (1.5)	7.7 (2.4)

MNA: Mini Nutritional Assessment; SPMSQ: Short Portable Mental Status Questionnaire; SD: standard deviation.
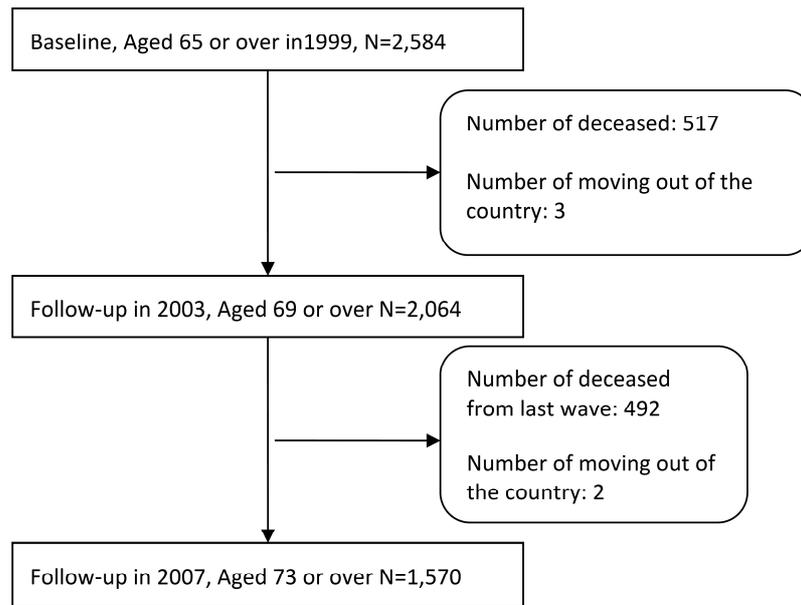
Figure 1. Attrition of the studied sample across the three survey waves, from 1999 to 2007.

(from the dichotomous MNA scores), 67 men (4.7%) and 77 women (6.6%) experienced both the dangers (at risk of malnutrition and eating alone). In total, 319 cases were at risk of malnutrition but had their meals with others, and 336 participants ate alone but had a normal nutritional status. Considerable gender differences were observed in educational attainment. The mean years of schooling among men was approximately 6.2 years, whereas among women it was only 2.4 years. On average, the male respondents also had higher SPMSQ scores than did their female counterparts. Regarding the two social support indicators, approximately 11.3% of the respondents lived alone and 60.2% of the elderly participants were married or had companions at baseline.

The GEE results for the changes in cognitive functioning among the male and female respondents over an 8-year period are shown in Tables 2 and 3, respectively.

When examining the results from Table 2, which consists of the male subsample only, no significant differences were observed in the changes of SPMSQ scores between those with both the dangers (at risk of malnutrition and eating alone) and those with other combinations. Among the men, older participants were more likely to experience a significant decline in their SPMSQ scores (an average 0.03-point yearly decrease in their SPMSQ scores over the 8 years), and participants with more years of schooling (a significantly positive coefficient) were less likely to experience cognitive decline during the study period. Notably, the time

Table 2. Results of the generalized estimating equation regression model for predicting cognitive changes, 1999–2007 (men only).

Variable	Model 1		Model 2	
	β coefficient	95% CI	β coefficient	95% CI
Hypertension (no)	-0.02	(-0.14, 0.09)	-0.02	(-0.14, 0.09)
Diabetes (no)	-0.11	(-0.30, 0.08)	-0.11	(-0.30, 0.08)
Heart disease (no)	-0.04	(-0.20, 0.11)	-0.04	(-0.20, 0.11)
Alcohol drinking (no)	0.02	(-0.09, 0.13)	0.02	(-0.09, 0.13)
Exercise (≥3times/week)				
Never	-0.10	(-0.24, 0.03)	-0.10	(-0.24, 0.03)
≤2 times/week	-0.05	(-0.31, 0.21)	-0.04	(-0.31, 0.22)
Live alone (otherwise)	--	--	-0.07	(-0.32, 0.18)
Nutritional status and eating alone combined (normal nutri-tion & meal with others)				
At risk of malnutrition & eating alone	-0.34	(-0.76, 0.08)	-0.38	(-0.84, 0.09)
At risk of malnutrition & meal with others	-0.10	(-0.32, 0.11)	-0.10	(-0.32, 0.11)
Normal nutrition & eating alone	0.02	(-0.13, 0.16)	-0.03	(-0.22, 0.17)
Time (baseline in 1999)				
Wave 3 in 2007	-0.80***	(-0.95, -0.66)	-0.80***	(-0.95, -0.66)
Wave 2 in 2003	-0.24***	(-0.34, -0.14)	-0.24***	(-0.34, -0.14)
Age in 1999	-0.03***	(-0.04, -0.02)	-0.03***	(-0.04, -0.02)
Years of education	0.04***	(0.02, 0.05)	0.04***	(0.02, 0.05)

*$p<0.05$; **$p<0.01$; ***$p<0.001$.
The reference groups for categorical predictors are in parentheses.

1. The male subsample
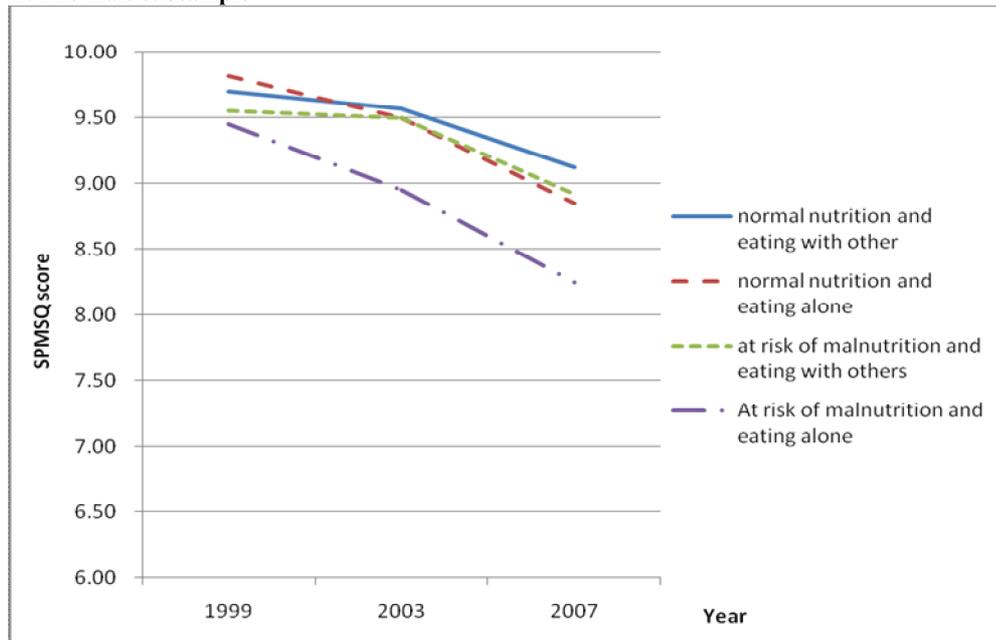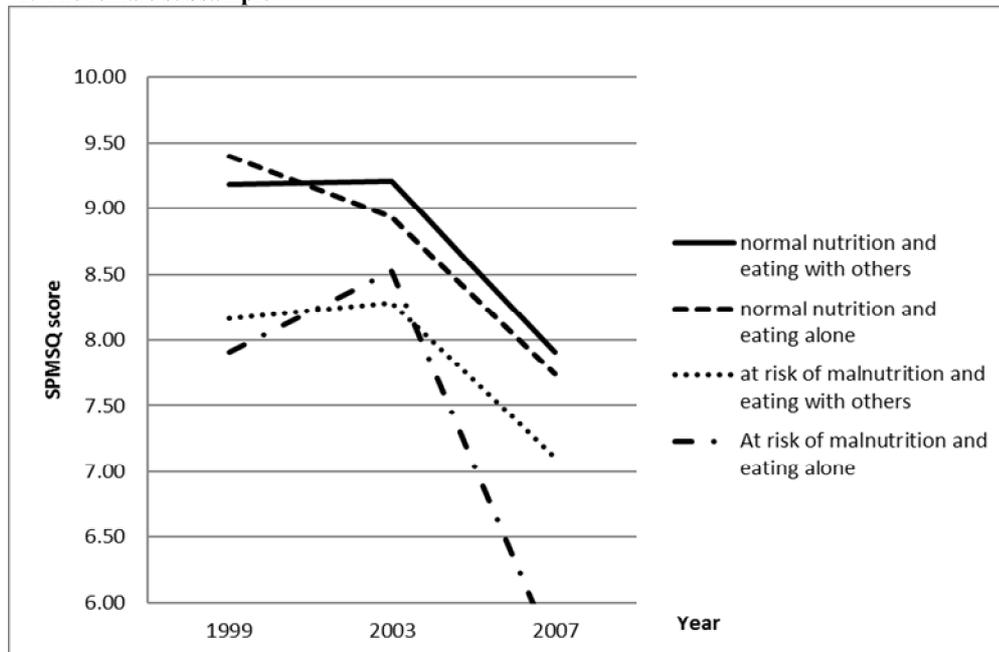

2. The female subsample

Figure 2. The mean SPMSQ scores at baseline and at each of the follow-up waves, separated by gender.

variable included in the GEE model was also highly significant, implying a strong within-subject effect over time. For example, compared with the baseline, a respondent's SPMSQ score had an 0.8-point ($p<0.001$) drop by the third follow-up in 2007. Living alone (the added predictor in Model 2) was not a significant predictor for cognition changes among this sample. In our screening analyses, eating alone was significantly correlated with living alone.

Regarding the subsample of women, Table 3 shows that female participants who were at risk of malnutrition and ate alone were significantly more likely to experience cognitive decline (an average 0.88-point decrease in their SPMSQ scores, $p<0.01$) than were those who had a normal nutritional status and ate with others. Contrary to

the results from the subsample of men, the combined impact of malnutrition and eating alone was only observed among older women. Meanwhile, female respondents who were at risk of malnutrition and ate meals with others were also more likely to experience cognitive decline (an average 0.72-point decrease in their SPMSQ scores, $p<0.001$) compared with the reference group. Female respondents whose weekly exercise frequency was zero and who had hypertension were associated with a significant decline in their cognitive functioning over the study period. A significant within-subject decline in SPMSQ score decline was again observed over time. On average, a female respondent's SPMSQ score showed a 1.62-point ($p<0.001$) drop by the third follow-up in 2007 compared with the score at

Table 3. Results of the generalized estimating equation regression model for predicting cognitive changes, 1999–2007 (women only)

Variable	Model 1		Model 2	
	β coefficient	95% CI	β coefficient	95% CI
Hypertension (no)	-0.28[*]	(-0.50, -0.05)	-0.28[*]	(-0.50, -0.05)
Diabetes (no)	-0.18	(-0.48, 0.12)	-0.18	(-0.48, 0.12)
Heart disease (no)	0.02	(-0.22, 0.27)	0.02	(-0.22, 0.27)
Alcohol drinking (no)	0.24	(-0.15, 0.64)	0.24	(-0.15, 0.64)
Exercise (≥3times/week)				
Never	-0.42[***]	(-0.64, 0.19)	-0.42[***]	(-0.64, -0.19)
≤2 times/week	-0.36	(-0.84, -0.13)	-0.36	(-0.84, 0.12)
Live alone (otherwise)	--	--	0.08	(-0.38, 0.54)
Nutritional status and eating alone combined (normal nutrition & meal with others)				
At risk of malnutrition & eating alone	-0.88[**]	(-1.49, -0.26)	-0.85[**]	(-1.47, -0.24)
At risk of malnutrition & meal with others	-0.72[***]	(-1.13, -0.31)	-0.72[***]	(-1.13, -0.31)
Normal nutrition & eating alone	0.01	(-0.29, 0.32)	0.05	(-0.33, 0.43)
Time (baseline in 1999)				
Wave 3 in 2007	-1.62[***]	(-1.85, -1.38)	-1.62[***]	(-1.85, -1.38)
Wave 2 in 2003	-0.34[***]	(-0.51, -0.17)	-0.34[***]	(-0.51, -0.17)
Age in 1999	-0.07[***]	(-0.10, -0.05)	-0.07[***]	(-0.10, -0.05)
Years of education	0.13[***]	(0.11, 0.16)	0.13[***]	(0.11, 0.16)

[*]$p<0.05$; [**]$p<0.01$; [***]$p<0.001$.
The reference groups for categorical predictors are in parentheses.

baseline.

Finally, changes in the mean SPMSQ scores for each of the four combinations of the two variables (nutritional status and eating alone) are plotted in Figure 2. Men experienced a slower decline in the average SPMSQ scores over the study period, and a much steeper decline in the average SPMSQ scores was seen among the older women.

DISCUSSION

The social costs of cognitive impairment or dementia constitute a tremendous burden, especially for informal caregivers and families. As the worldwide population ages rapidly, dementia remains a major public health concern. Using a nationally representative sample of older Taiwanese individuals aged 65 years in 1999, this study examined the combined effect of two dangers, namely the risk of malnutrition and eating alone, on the changes in cognitive functioning over an 8-year period. Consistent with other studies,[8] our results confirmed that nutritional status, measured using the MNA scale, was a salient predictor for cognitive decline among older adults. Older people with malnutrition or an under-nutritional status had a higher risk of cognitive decline during the study period.

From the results of the GEE models, participants with a risk of malnutrition were more likely to experience cognitive decline, regardless of the presence of others during meals. Among the female respondents with a poor nutritional status, if they were also eating their meals alone, they exhibited a steeper decrease in their SPMSQ scores over time. The difference between the coefficient for the group with two dangers (at risk of malnutrition and eating alone) and the coefficient for the group of women with just one danger was 0.16; however, the difference was not significant (*p*>0.05). Nevertheless, given the statistically significant association between eating alone and a risk of malnutrition among women, eating alone could still be an important risk factor

among older Taiwanese women with a poor nutritional status.

This finding can also be noted from the changes in the mean SPMSQ scores calculated from available cases at each wave of the survey. Although these scores were calculated from only the available cases at each wave of the survey, they were still indicative of a greater decline among the group of women with both the dangers (poor nutritional status and eating alone). This group of women had the lowest mean SPMSQ scores throughout the three survey waves and a much steeper decline than the other groups did.

Why a significant association between a poor nutritional status and cognitive decline was only seen among this sample of elderly women is not entirely clear. However, a considerable gender differential was noted in the average years of schooling (6.2 years for men versus 2.4 years for women), and a lower level of education was a strongly associated with cognitive decline. The huge differential in the years of schooling reflects the considerable gender inequality between men and women born in Taiwan before 1930. In that time, parents with limited resources would send only their sons to school. According to social mobility studies,[31] parental generation's socioeconomic status (SES) is largely be reproduced in their children. Using the father's educational attainment as an indicator for the childhood SES among the cohort of Taiwanese persons born before 1929, a woman with an illiterate father scored significantly lower in the MNA scale measured in 1999, when she was aged ≥70 years, than did men (data not shown). This gender gap in education attainment is jointly associated with the poor nutritional status and cognitive functions among this cohort of older Taiwanese adults.

Across the course of life, eating with others, particularly family, is associated with healthier dietary outcomes.[32] As people age, they gradually lose their social ties and become more vulnerable to social isolation,

which could lead to a deteriorated nutritional status. By contrast, research in this area has confirmed that a socially integrated lifestyle in late life protects against dementia.[12] For example, Van Gelder et al used marital status as an indicator of social integration and reported that the 10-year cognitive decline was the lowest in men who remained married compared with in those who remained unmarried or were no longer married.[33]

Eating alone can be seen as proxy of lacking support ties. Evidence reveals that persons living alone are more likely to eat their meals alone or skip meals. A large-scale survey of older Japanese individuals reported that eating alone and living alone are jointly associated with a higher prevalence of unhealthy dietary behaviours, which might have a negative impact on old people's nutritional status.[15] However, in our analysis, when living alone was added into the GEE models, it was insignificant. Nevertheless, our results still indicated that cognitive functioning seems to deteriorate at a greater speed among older women who are at risk of malnutrition while eating meals alone. Apparently, eating alone might be a sign preceding a more socially isolated lifestyle. Nutritional programs tailored to older adults should not just focus on what they eat. Equally important is what can be done to prevent older people, especially elderly women, from being social isolated.

This study had some limitations. First, all longitudinal surveys inevitably encounter the problem of sample attrition and missing cases when pooling data collected over time. We adopted GEE models, which are appropriate for handling longitudinal data with attrition and missing data. However, women outlive men. As sample attrition occurred in the follow-up waves, the poor SPMSQ scores of men with an impaired cognition were not available for analysis because they were more likely to die before the next survey interview (over 99% of the sample attrition was due to death).

Second, the SPMSQ mean scores for the 2003 and 2007 follow-ups in Figure 2 were calculated from available participants in those particular waves only. The purpose was to illustrate the gender difference in the changes of SPMSQ scores over time for the four combinations of the two dangers (at risk of malnutrition and eating alone). Respondents who died after the baseline were not accounted for in these figures.

In conclusion, the nutritional status, measured by the MNA scale, is an important predictor for cognitive decline among a nationally representative sample of older Taiwanese adults over an 8-year period. The combined impact of malnutrition and eating alone was observed only among older women. To prevent social isolation, programs designed for older adults should focus on what they eat as well as who they eat their meals with, especially among elderly women.

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