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TITLE PAGE

Gender differences in longevity in free-living older adults who eat-with-others: a prospective study

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ABSTRACT

Objectives: Social activities such as 'eating-with-others' can positively affect the ageing process. We investigated the gender-specific association between eating arrangements and risk of all-cause mortality among free-living older adults.

Setting: A representative sample from the elderly Nutrition and Health Survey in Taiwan during 1999-2000.

Participants: Some 1,894 participants (955 men and 939 women) who aged ≥65 and completed eating arrangement question as well as confirmed survivorship information.

Primary and secondary outcome measures: Eating arrangements, health condition, and 24-hour dietary recall information were collected at baseline. We classified eating arrangements as the daily frequency of eating-with-others (0–3). Survivorship was determined by the National Death Registry until the end of 2008. Cox proportional-hazards regression was used to assess the association between eating-with-others and mortality risk.

Results: Overall, 63.1% of men and 56.4% of women ate with others 3 times a day. Both men and women who ate with others were more likely to have higher meat and vegetable intakes, and greater dietary quality than those who ate alone. The hazard ratios (HRs) (95% CI) for all-cause mortality when eating-with-others 2 and 3 times daily were 0.46 (0.28–0.61), 0.67 (0.52–0.88) in men and 0.68 (0.42–1.11), 0.86 (0.64–1.16) in women, compared with those who ate alone. Multivariable HRs (95% CI) were 0.43 (0.25–0.73), 0.63 (0.41–0.98) in men and 0.68 (0.35–1.30), 0.69 (0.39–1.21) in women. With further adjustment for financial status, HR was reduced by 54% in men who ate with others twice a day. Pathway analysis shows this to be dependent on improved dietary quality by eating-with-others.

Conclusions: Eating-with-others is an independent survival factor in older men. To providing a social environment which encourages eating-with-others may benefit survival of older people, especially for men.

Key words: elderly, diet, mortality, social activities

STRENGTHS AND LIMITATIONS OF THIS STUDY

- Use of a representative free-living Taiwanese cohort with 10 years' follow-up for survival.
- Study design provided an understanding of eating arrangements for older adults in a community setting.
- A comprehensive assessment of the gender-specific associations between eating-with-others and mortality for older adults.
- The frequency, but not duration of time spent eating alone or eating-with-others was considered.
- Participants were mainly of Chinese ethnicity from Taiwan so that the generalisability of findings may be limited.

INTRODUCTION

Social engagement, such as interpersonal relations (e.g., contact and transactions with friends), exchange of information, and receiving and providing emotional support, is a key component of healthy ageing, besides avoiding disease and maintaining physical and cognitive functions.[1] However, opportunities to interact are frequently reduced after retirement because of factors such as loss of physical capacity, loss of mobility, and solitary living.

The word "Meal" means the event of eating and what is eaten. For this reason, social interaction is considered one of the criteria for a meal.[2] Numerous countries offer nutritional programs, such as congregate meals or meals-on-wheels programs, to encourage eating in a social setting.[3] The inverse correlation between eating-with-others and risk of depression has been studied extensively.[4-6] Additionally, eating alone can be analyzed as a separate risk factor from living alone with regard to depression or depressive symptoms.[5 6] Eating-with-others can potentially improve dietary quality, variety, and energy intake through social facilitation. Depression and poor dietary quality increase the risk of chronic disease and mortality in older adults.[7 8] Solitary eating has been associated with a higher risk of mortality among small cohorts of elders in Botswana and the United States.[9 10] But, it is unclear whether the daily frequency of eating-with-others is associated with survivorship.

Gender is also a factor in the quality of older people's lives; for example, women frequently exhibit more health-seeking behavior.[11 12] Yet men face higher risks of depression after widowhood than do women.[13] Exploring the gender-specific associations between solitary eating and mortality among older adults is potentially of public health value.

Providing simple, achievable steps for healthy ageing can prolong life, maintain quality of life over an extended duration, and limit physical deterioration, all of which are beneficial to public health. The purpose of this study was, therefore, to evaluate whether the daily frequency of eating-with-others is associated with all-cause mortality in a representative, free-living,

Taiwanese cohort of older men and women.

SUBJECTS AND METHODS

Participants

Participants aged 65 and over were recruited from the Elderly Nutrition and Health Survey in Taiwan during 1999–2000. The details of the survey design and sampling method have been published elsewhere.[14] In total, 1,937 older people completed face-to-face interviews with trained interviewers. We excluded 40 participants with incorrect identification or incorrect identity numbers and those who did not provide relevant or required information. After which 1,894 participants (955 men and 939 women) remained in the study. Trained interviewers collected data on sociodemographics, dietary habits and intake, and disease history. All participants signed informed consent forms prior to being interviewed. This project was approved by the Ethics Committees of the National Health Research Institute and Academia Sinica, Taiwan.

Eating arrangement

Eating arrangements were assessed by asking participants whether they usually ate breakfast, lunch, and dinner with others. Their responses were recorded as one of the following four options: eat alone, eat with spouse, eat with children or relative(s), and eat with friend(s) or neighbor(s). We then classified the eating arrangements as eating-with-others 0 (eat alone), 1, 2, 3 times a day.[15] Information was also obtained about the person responsible for meal preparation.

Dietary assessment

Information on frequency of dietary intake was collected using a validated simplified food

frequency questionnaire.[16] Dietary quality and nutritional intake were measured through one-day 24-hour dietary recall. The dietary quality was evaluated using the dietary diversity score (DDS), which is based on the consumption of a half serving of the following six food groups daily: grains; meat, fish, or eggs; dairy; vegetables; fruits; and oil or fat. The DDS score ranges from 0 to 6, with a higher score representing higher dietary quality. The method of nutrient intake calculation is described elsewhere.[7]

Other variables

Participants were also asked how frequently they cooked or aided with cooking (excluding ready-to-eat meals), and their responses were recorded as never, sometimes, often, or usually. Participants were then asked how many people they lived with. The response "0" was defined as living alone.

Health-related quality of life was measured by a 36 item Short Form (SF-36) in a validated traditional Chinese version. A total of 8 dimensions of health, included physical functioning, role limitations due to physical problems, mental health, role limitations due to emotional problems, social function, bodily pain, vitality and general health. The score was calculated by the norm-based scoring system (μ=50, σ=10) and standardised. Higher scores indicated a better quality of life.[17]

Disability was evaluated by activities of daily living (ADL) which included 9 questions about self-care task difficulty in an older adult's daily life.

Outcome ascertainment

National Death Registry data were obtained from Taiwan's Ministry of Health and Welfare. We linked the NAHSIT dataset to the National Death Registry dataset using the participant ID to determine survival rates. Follow-up time was calculated from date of interview to date of

death or until December 31, 2008.

Statistical analysis

All data analyses were stratified by gender. Categorical variables and continuous variables were presented as n (%) or mean ± standard errors (SE). Chi-square and ANOVA were used to determine the association between eating arrangements and baseline characteristics for categorical or continuous variables, respectively. The Cox proportional-hazards regression model was used to evaluate the association between daily frequency eating-with-others and risk of all-cause mortality. Additional factors were age, education level (illiterate, primary school, high school and above), marital status (married, bereaved, other), region (Hakka, mountains, Eastern Taiwan, Penghu, Northern Taiwan 1–3, Central Taiwan 1–3, Southern Taiwan 1–3), living arrangement (live alone, live with others), BMI (<18.5, 18.5–23.9, 24.0–26.9, ≥27), DDS (≤3, 4, 5, 6), cooking frequency (never, sometimes, often, frequently), appetite status (good, fair, poor), ADL and self-rate financial statue (more than enough, just enough, not enough). All data analyses were performed using SAS 9.2 and SUDAAN 9.0 to adjust for the design effect of sampling.

To explore the pathways which might connect eating-with-others to survival, we have considered the intermediates of dietary quality (DDS), physical functioning, mental health, and general health. The first linkage, using continuous variables, has been assessed by Pearson's partial correlation coefficients. The second linkage to risk of mortality, as coefficients, has been assessed by the Aalen additive hazards model.[18]

RESULTS

In total, 63.1% of men and 56.4% of women ate with others 3 times a day. The mean age of men and women who ate alone was significantly higher than those who ate with others 3 times

(74.9 vs. 72.7 years and 75.3 vs. 73.0 years). For both genders, those who ate with others were more likely to be married, better financial status, living with others, and less cooking than were those who ate alone. Men who ate alone had significantly higher ADLs than those who ate with others (p=0.004). (Table 1)

Table 2 presents the dietary quality and food intakes for daily frequency of eating-with-others by gender. A total of 24.1% of men and 30.2% of women who ate alone had a poor dietary quality (DDS ≤3), compared to those who ate with others 3 times daily (12.1%, 17.5% respectively). Men who ate alone ate less meat (1.02 vs. 1.30 times/d) and vegetables (1.90 vs. 2.47 times/d) than did those who ate with others 3 times a day (p<0.05). Women who ate with others 3 times a day tended to eat more meat (1.13 vs 0.81 times/d), seafood (0.99 vs. 0.70 times/d), eggs (0.38 vs. 0.23 times/d), and vegetable (2.52 vs. 2.09 times/d) intake than did those who ate alone (p<0.05). Further, women who ate alone had lower fat (24.7 vs. 28.9 g/1000 kcal/d) intakes, but higher carbohydrate (155 vs. 144 g/1000 kcal/d) intakes compared with those who ate with others (p<0.05).

Regarding meals, 57.6%, 59.0%, and 60.0% of men and 74.0%, 68.1%, and 67.7% of women prepared breakfast, lunch, and dinner respectively when eating alone. Men were more likely to eat out (highest of 24.3% for lunch) when eating-with-others once a day compared with women (highest of 7.73% for lunch). Furthermore, men who prepared meals for themselves when eating alone were more likely to have purchased the food (61.2%) than were those who ate with others.

Men who ate with others twice per day have significantly high physical functioning compared with other groups (p=0.044). For women, who ate with others once per day have higher physical functioning (50.7 vs. 45.2) and role limitations due to physical problem (51.4 vs. 46.1) compared with those who ate alone. (Table 3)

Table 4 presents the association between daily frequency eating-with-others and risk of

all-cause mortality by gender. In the crude model, the HRs (95% CI) of risk of all-cause mortality for who ate with others 2 or 3 times a day were 0.42 (0.28–0.61), 0.67 (0.52–0.88) in men and 0.68 (0.42–1.11), 0.86 (0.64–1.16) in women compared with those who ate alone, respectively. When adjusted for age, education, marital status, region, living arrangement, cooking, appetite status, ADL, DDS, BMI, the HRs (95% CI) were 0.43 (0.25–0.73), 0.63 (0.41–0.98) for men and 0.68 (0.35–1.30), 0.69 (0.39–1.21) for women who ate with others 2 or 3 times a day. With further adjustment for financial status, the risk of mortality is reduced by 54% (HR: 0.46, 95% CI: 0.28–0.77) and 44% (HR: 0.66, 95% CI: 0.43–1.02) for men who ate with others 2 or 3 times a day.

The pathway analyses are shown in Figure 1. For men, there are significant positive associations between eating-with-others frequency and dietary quality (DDS) (p=0.006) as well as mental health (p=0.0009). In turn, better dietary quality (p<0.0001) is associated with less mortality risk, as are physical functioning (p<0.0001) and general health (p=0.007). For women, eating-with-others is not associated with any of dietary quality, physical functioning, mental health or general health; however, dietary quality (p=0.0004) and physical functioning (p<0.0001) are inversely associated with mortality risk, while mental health (p=0.043) is positively associated.

DISCUSSION

This study explored the gender-specific associations between eating arrangement and risk of mortality by observing a population-representative older adult cohort with a 10-year follow-up in an Asian country. Eating-with-others was inversely associated with risk of mortality, more evident in men than in women.

Food intake when eating-with-others

Eating-with-others has numerous beneficial effects on health. A randomized controlled trial at a Dutch nursing home found that family-style meals that included the presence of others increased the energy intake and reduced the prevalence of malnutrition. Those who ate with others ate more than those who ate alone. Social eating may stimulate intake through extension of meal duration and improved ambiance.[19] The presence of others in the household did not affect energy intake, but the presence of others during mealtime did, with an average of 114 calories more per meal than those who ate alone.[20] Eating socially also improved dietary quality and diversity.[21] However, the present study shows that after control for dietary quality in the model, eating-with-others and mortality remains associated. A possible reason for this is that solitary eating is often associated with depression,[4-6] in turn associated with mortality.

Eating-with-others and mortality

Our findings are consistent with several studies from Western countries. The Nutrition Screening Initiative (NSI) checklist, a tool for malnutrition screening and awareness in older adults in the US, asks questions regarding solitary eating. In a cohort study with 581 community-dwelling older adults, who ate more than 17 meals alone per week, exhibited a 2.07-fold higher risk of mortality (RR=2.07, 95% CI=1.49–2.86) over an 8–12-year period.[10] Another study in Bostwana found that older adults who ate alone had a higher risk of death (OR=6.7, 95% CI=2.2–20.0).[9] However, these studies did not factor in gender.

Eating alone and gender

In the present study, men who ate with others had a lower risk of mortality than did those who ate alone, for several probable reasons. Men who ate with others had better dietary quality and a higher vegetable intake than those eating alone. We also found that men who ate alone were more likely to eat out, not prepare meals by themselves, and frequently skip meals than did

women. A Japanese cohort study discovered that men who ate alone were more likely to be underweight and skip meals and less likely to eat fruits and vegetables.[21] Underweight older adults with poor dietary quality and low fruit and vegetable intakes have been associated with a higher risk of mortality.[7 22] Furthermore, in our study, eating out is often associated with high-fat foods with poor quality. Men who were solitary eaters had low carbohydrate, protein, dietary fiber, and other nutrient intakes, but a higher fat intake than those who ate with others, although the differences were non-significant.

Compared with Japan,[21] in our study men have a higher rate of solitary eating, but women have a lower rate. Taiwanese men who eat alone are more likely to be unmarried or live separately from their spouse. We found that the eating companionship of men who ate with others was usually their spouse or children rather than friends or neighbours (data not shown). Davis et al. found that dietary patterns of older men had stronger associations with living arrangements than did those of older women.[23] Cooking itself is a physical activity and a cognitive function, and in Taiwanese culture women are more likely to prepare meals. Men eat out or buy ready-to-eat food more than they cook. In this study, men (47.0%) cooked less than did women (63.9%) when eating alone (Table 1). Men who ate alone shopped more than did women who ate alone (27.6% vs. 9.6%).

Pathways from eating-with-others to survival

For men but not women, pathway analyses indicate that dietary quality, assessed as dietary diversity, provides a potential connection between the social aspect of eating-with-others and survival (Figure 1). This underscores the likely basic importance of nutritional factors in life-long health, but draws attention to the social as well as the biomedical role of food in health. For men, on pathway analysis, eating-with-others is associated with better mental health. Since pathway analysis requires that all independent variables are continuous, this may

have resulted in an absence of a significant direct association of eating-with-others with mortality due to its frequency not being linearly related to mortality; this contrasts with the survival analyses by Cox regression (Table 4). In addition, by pathway analysis, each of physical functioning and general health are themselves important in the prediction of mortality risk in men. It remains conceivable that the dietary quality that men achieve, irrespective of eating-with-others, plays a role in each of physical functioning and general health, which is evident in this population.[7 17]

In the case of women, dietary quality directly and favourably predicts survival, but this connection is not found to be dependent on eating-with-others. Perhaps women can achieve the biomedical benefit of survival through diet without the need for its social function. In addition, women have a more favourable survival with better physical functioning. Somewhat surprisingly, better mental health is unfavourably associated with survival, although this is weakly significant. It is possible that confounders that have not been considered in this pathway analysis might account for this mental health association with mortality in older women. For example, in devoting themselves to the care of others, or in dealing successfully with a relative socio-economic disadvantage in widowhood, a sense of wellbeing may obtain, while health adversity supervenes.

Limitations

There are some limitations to this study. First, the association may be affected by the duration of time spent eating alone or eating-with-others, which was not considered. Second, in Taiwanese society, older people are more likely to live with and depend on their families, so the culturally specific nature of this study may limit its applicability elsewhere. The study should be considered within a Taiwanese (of perhaps a broader Asian) context. As with cohort studies in general, there may have been confounders not considered which might have explained the

associations presented. The study itself, however, has sought to consider the circumstances of eating which are usually neglected in the exploration of food and nutrient health relationships. The pathway analyses are an attempt to encompass more of the explanatory models for these relationships by way of inclusion of physical, mental and general health. The gender differences which are now recognised here and in other reports for the respective health roles of dietary quality on the one hand, and with whom the food is consumed on the other, are a challenge to more gender comprehensive public health policy.

Conclusions

Eating socially may benefit survival in elderly men through the adjunct of dietary quality; it is also positively associated with men's mental health. For women, dietary quality is associated with survival advantage which is not apparently dependent on eating-with-others. The relative gender advantage in longevity that women have in this population is not adequately explained in the present study, except that they are likely to be the ones who eat with men who benefit from this social role of food. Thus, for men and women, the provision of a healthy social environment which increases social interactions should improve health outcomes.

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None of the authors has any conflicts of interest to declare.

AUTHOR'S CONTRIBUTION

YCH, HLC, MLW and MSL designed the study; YCH, HLC and YTCL performed statistical analysis; YCH, MLW, YTCL, and MSL wrote the paper; MSL had primary responsibility for the final content.

COMPETING INTERESTS

No author has any conflict of interest in regard to this paper.

FOUNDING

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DATA SHARING STATEMENT

No additional data are available.

ETHICS

This project was approved by the Ethics Committees of the National Health Research Institute and Academia Sinica, Taiwan.

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LEGENDS

Figure 1. Pathway analysis for the associations of eating-with-others and all-cause mortality. All values are presented as β coefficients with their p values.

Table 1. The baseline characteristics by daily frequency for eating-with-others

Variables	Daily frequency for eating-with-others											
	Men						Women					
	Total	0	1	2	3	p value	Total	0	1	2	3	p value
N		142	57	126	630			174	79	140	546	
%		14.3	6.96	15.6	63.1			17.8	10.2	15.7	56.4	
Median of follow-up (yrs)		8.17	8.28	8.76	8.67			8.55	8.89	8.75	8.74	
Age at baseline (yrs)	72.9±0.33	74.9±0.65	71.8±0.74	72.4±0.73	72.7±0.44	0.042	73.4±0.44	75.3±0.76	72.9±0.65	72.9±0.88	73.0±0.39	0.020
Education						<0.0001						0.963
Illiterate	18.8	24.2	16.7	8.8	20.3		56.0	57.5	55.6	52.3	56.6	
Some up to primary school	46.6	52.3	43.5	48.4	45.2		32.3	32.5	32.0	33.8	31.9	
High school and above	34.7	23.5	39.9	42.8	34.5		11.7	10.0	12.4	13.8	11.5	
Marital status						<0.0001						<0.0001
Married	78.6	36.1	48.2	75.0	95.5		49.48	15.5	19.6	37.8	68.8	
Bereaved	14.3	37.8	38.8	17.5	5.43		48.12	80.6	71.1	60.7	30.3	
Others	7.15	26.1	13.0	7.55	2.11		2.40	3.87	9.32	1.56	0.95	
Live alone	13.7	60.4	0.00	9.67	1.47	<0.0001	10.3	49.4	6.43	2.91	0.42	<0.0001
Whether enough money						0.030						0.001
More than enough	78.4	71.8	79.9	85.8	77.8		75.0	64.1	63.1	78.3	79.5	
Just enough	19.2	21.7	20.2	13.0	20.1		21.0	28.7	28.8	21.0	17.2	
Not enough	2.46	6.52	0.00	1.26	2.14		4.01	7.23	8.13	0.70	3.25	
Smoker	65.7	70.5	82.0	63.9	63.2	0.078	4.92	2.44	2.55	5.34	6.01	0.171
Appetite status						0.232						0.112
Good	38.5	33.0	45.0	36.6	39.4		30.4	24.9	42.9	31.7	29.5	
Fair	55.5	62.5	41.5	59.4	54.5		59.4	57.2	48.8	61.5	61.4	
Poor	6.07	4.54	13.5	4.09	6.08		10.2	17.9	8.34	6.87	9.14	
Body mass index (kg/m^2)	23.3±0.15	22.9±0.46	23.2±0.64	23.2±0.33	23.3±0.17	0.738	23.9±0.25	23.3±0.56	25.1±0.43	24.5±0.50	23.8±0.28	0.0002
< 18.5	7.07	11.2	10.4	7.53	5.66		7.01	8.07	0.00	3.83	8.72	
18.5–23.9	52.5	54.1	53.4	50.6	52.6		44.0	51.0	39.6	40.9	43.6	

24.0–26.9	28.0	19.0	19.9	34.0	29.2		27.8	24.7	34.1	25.3	28.1	
≥ 27.0	12.5	15.7	16.3	7.91	12.6		21.3	16.3	26.3	30.0	19.6	
Physical activity (MET/day)						0.173						0.017
<1.5	51.6	45.3	44.0	51.2	54.0		61.1	60.5	51.0	52.9	65.4	
1.5–2.9	11.3	14.3	17.9	14.2	9.17		11.8	14.3	6.16	14.0	11.4	
≥3	37.1	40.4	38.1	34.7	36.8		27.1	25.2	42.8	33.1	23.2	
Shopping						0.239						0.037
<1/wk	43.8	34.2	44.5	45.9	45.5		54.9	65.3	46.6	50.9	54.3	
1/wk	12.7	13.5	15.2	13.0	12.2		13.6	10.2	14.8	18.4	13.1	
1–2/wk	23.3	24.7	21.0	19.6	24.2		19.8	14.9	24.7	22.0	19.8	
Everyday	20.2	27.6	19.3	21.6	18.3		11.7	9.63	13.9	8.74	12.9	
Current cooking activity						<0.0001						0.004
Never	58.4	33.2	44.1	58.1	65.8		26.8	24.1	12.1	31.5	29.1	
Sometimes	20.3	13.1	19.2	24.8	20.8		13.2	5.10	9.1	16.0	15.8	
Often	6.83	6.63	11.4	9.63	5.66		10.5	6.94	20.0	12.6	9.23	
Usually	14.5	47.0	25.2	7.46	7.69		49.5	63.9	58.8	39.9	45.9	
Activities of daily living	0.33±0.05	0.52±0.18	0.19±0.15	0.07±0.05	0.36±0.07	0.004	0.57±0.08	1.18±0.34	0.27±0.13	0.28±0.17	0.50±0.10	0.088

All data weighted for unequal probability of sampling design by SUDAAN. Categorical variables are presented as n (%), and continuous variables are presented as mean±SE.

ANOVA and chi-square were used for continuous and categories variables to test difference between the groups by gender.

Table 2. Food, nutrient intakes and daily frequency of eating-with-others by gender

	Daily frequency for eating-with-others									
	Men					Women				
	0	1	2	3	p value	0	1	2	3	p value
Food preparation, %										
Skipping meals	11.2	16.5	5.75	2.96	0.008	6.54	8.45	4.76	4.27	0.370
Who prepared breakfast?					<0.0001					0.003
Self	57.6	45.7	37.0	12.7		74.0	76.2	61.3	57.2	
Others	28.6	36.4	56.1	85.8		23.9	20.7	36.1	41.5	
Eating out	13.8	17.9	6.96	1.52		2.14	3.12	2.62	1.35	
Who prepared lunch?					<0.0001					0.0001
Self	59.0	40.8	11.3	9.07		68.1	74.2	48.0	53.1	
Others	31.3	34.9	85.0	89.0		26.3	18.1	50.0	45.2	
Eating out	9.72	24.3	3.66	1.90		5.59	7.73	1.96	1.63	
Who prepared dinner?					<0.0001					0.009
Self	60.0	25.0	6.20	8.52		67.7	60.1	44.6	51.4	
Others	32.9	74.0	92.1	90.7		30.2	39.9	55.4	48.1	
Eating out	7.05	1.03	1.73	0.76		2.11	0.00	0.00	0.51	
If you need to prepare meals for yourself, who gets the food?					<0.0001					0.118
Never prepare	6.21	15.8	9.38	9.32		8.37	1.67	5.24	6.60	
Self	61.2	23.4	21.2	18.6		60.2	67.4	48.2	48.4	
Others	32.6	60.8	69.5	72.1		31.4	31.0	46.6	45.0	
Dietary diversity score, %					0.010					0.001
≤3	24.1	22.1	12.2	12.1		30.2	20.7	8.05	17.5	
4	30.0	41.4	30.2	32.4		24.1	31.2	31.5	31.3	
5	35.4	28.4	39.6	35.8		25.1	31.7	42.8	34.8	

6	10.8	8.13	18.0	19.7		20.7	16.4	17.6	16.4	
Food intake other than cereal (times/d), mean±SE										
Dairy	0.57±0.07	0.40±0.09	0.65±0.08	0.62±0.05	0.116	0.80±0.08	0.89±0.14	0.74±0.09	0.72±0.05	0.480
Meat	1.02±0.09	1.98±0.08	1.59±0.19	1.30±0.07	0.001	0.81±0.15	0.86±0.16	1.20±0.16	1.13±0.08	0.017
Seafood	0.86±0.18	0.93±0.12	1.08±0.12	0.99±0.08	0.524	0.70±0.10	0.92±0.12	0.91±0.09	0.99±0.07	0.026
Egg	0.44±0.08	0.39±0.05	0.46±0.05	0.46±0.03	0.687	0.23±0.03	0.36±0.04	0.36±0.03	0.38±0.03	0.003
Soy	0.48±0.09	0.43±0.06	0.47±0.06	0.45±0.04	0.824	0.39±0.06	0.50±0.10	0.61±0.07	0.51±0.05	0.063
Vegetable	1.90±0.18	1.84±0.13	2.57±0.13	2.47±0.12	0.004	2.09±0.14	2.28±0.13	2.35±0.14	2.52±0.14	0.011
Fruit	0.99±0.11	0.93±0.13	1.21±0.09	1.19±0.04	0.073	0.91±0.10	0.90±0.07	1.21±0.10	1.07±0.06	0.058
Total energy intake (kcal), mean±SE	1833±100	1849±123	1871±118	1815±77.4	0.940	1327±92.6	1518±126	1500±58.7	1521±84.3	0.206
Nutrient density (/1,000 kcal), mean±SE										
Carbohydrate (g)	132±4.79	137±5.21	139±2.58	139±2.71	0.438	155±3.55	143±5.63	144±3.31	144±1.82	0.028
Dietary fiber (g)	11.2±0.79	11.7±0.87	12.4±0.75	11.7±0.45	0.653	15.5±2.05	14.1±1.44	14.0±1.02	12.7±0.57	0.416
Fat (g)	32.1±1.42	30.5±2.15	30.2±1.28	29.5±0.82	0.377	24.7±1.13	29.7±2.30	29.2±1.50	28.9±0.85	0.002
Protein (g)	41.9±1.80	43.3±2.52	41.5±1.34	43.2±1.16	0.690	41.6±1.77	42.1±2.06	42.8±1.32	41.8±1.27	0.923
Vitamin B-1 (mg)	0.63±0.06	0.78±0.07	0.69±0.04	0.70±0.03	0.645	0.71±0.08	0.69±0.05	0.76±0.07	0.66±0.03	0.449
Vitamin B-2 (mg)	0.84±0.06	0.88±0.12	0.78±0.06	0.81±0.04	0.801	1.02±0.07	1.11±0.14	1.05±0.09	0.85±0.04	0.107
Vitamin B-6 (mg)	0.73±0.07	0.82±0.09	0.75±0.05	0.72±0.03	0.586	0.65±0.05	0.81±0.08	0.73±0.03	0.71±0.03	0.421
Vitamin C (mg)	92.5±12.2	88.4±12.8	87.5±8.69	90.6±6.18	0.984	110±9.32	103±11.5	131±20.0	105±7.72	0.597
Calcium (mg)	382±26.2	338±41.7	336±21.0	365±16.3	0.353	536±43.0	455±42.4	483±41.7	432±19.8	0.166
Magnesium (mg)	139±7.34	141±12.1	143±6.63	145±3.84	0.907	167±9.06	157±7.87	159±9.59	147±4.55	0.142

All data weighted for unequal probability of sampling design by SUDAAN.
ANOVA and chi-square were used for continuous and categories variables to test difference between the groups by gender.

Table 3. Health-related quality of life (SF-36) according to daily frequency eating-with-others by gender

	Daily frequency eating-with-others									
	Men					Women				
	0	1	2	3	p value	0	1	2	3	p value
General health	52.8□1.18	52.0±1.49	52.9±1.10	51.5±0.50	0.538	47.1±0.99	48.6±1.23	49.7±1.24	49.0±0.84	0.211
Mental health	51.4±0.91	49.3±1.88	52.3±1.13	52.5±0.50	0.222	47.8±1.30	47.3±1.45	48.8±1.27	49.2±1.02	0.542
Physical functioning	51.1±1.16	50.4±1.26	53.3±0.68	51.5±0.65	0.044	45.2±0.96	50.7±0.97	48.2±1.03	47.0±0.64	0.002
Body pain	51.2±1.20	51.5±1.63	52.8±1.04	51.9±0.68	0.529	46.5±1.08	47.4±1.20	49.5±1.00	48.0±0.69	0.112
Role limitations due to emotional problems	50.0±1.19	47.7±1.69	51.5±0.93	51.2±0.63	0.160	47.5±1.16	50.8±1.51	49.6±1.13	49.3±0.86	0.354
Role limitations due to physical problems	50.2±1.36	49.5±1.31	52.1±1.01	51.4±0.67	0.254	46.1±1.03	51.4±1.28	48.7±1.55	49.7±0.87	0.005
Social function	50.0±1.22	49.4±1.71	51.9±0.99	50.9±0.67	0.262	48.2±1.17	48.6±1.31	50.0±1.31	49.0±0.71	0.698
Vitality	51.0±1.32	49.4±1.76	51.7±1.02	51.8±0.68	0.591	47.1±0.95	49.2±1.72	48.1±1.45	48.1±0.75	0.553

All data weighted for unequal probability of sampling design by SUDAAN.

ANOVA was used for continuous and categories variables to test difference between the groups by gender.

Table 4. Gender-specific hazard ratios (95% CI) of association between eating-with- others and risk of mortality on older adults

	Daily frequency of eating-with-others							
	Men				Women			
	0	1	2	3	0	1	2	3
Deceased/survival, n	75/67	26/31	37/89	248/382	60/114	20/59	36/104	196/350
Crude model	1.00	0.90 (0.60–1.35)	0.42 (0.28–0.61)	0.67 (0.52–0.88)	1.00	0.53 (0.27–1.05)	0.68 (0.42–1.11)	0.86 (0.64–1.16)
Model 1	1.00	1.12 (0.71–1.78)	0.48 (0.31–0.74)	0.76 (0.57–1.03)	1.00	0.54 (0.24–1.23)	0.89 (0.53–1.49)	1.07 (0.77–1.49)
Model 2[†]	1.00	0.76 (0.37–1.56)	0.43 (0.25–0.73)	0.63 (0.41–0.98)	1.00	0.56 (0.29–1.07)	0.68 (0.35–1.30)	0.69 (0.39–1.21)
Model 3[†]	1.00	0.78 (0.39–1.55)	0.46 (0.28–0.77)	0.66 (0.43–1.02)	1.00	0.54 (0.27–1.06)	0.70 (0.36–1.36)	0.72 (0.40–1.27)

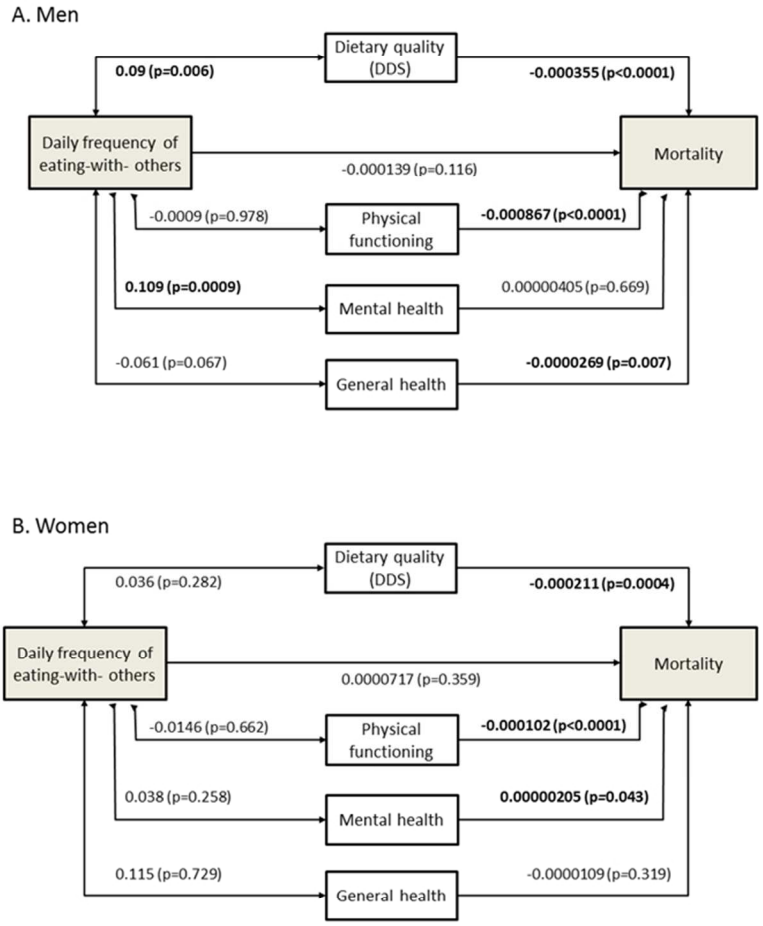
Data were weighted for unequal probability of sampling design by SUDAAN and estimated HR (95% CI) by using the Cox proportional hazard model.

Model 1: adjusted for age

Model 2: adjusted for age, education, strata, live alone, cook frequency, marital status, appetite status, dietary diversity score, activities of daily living and body mass index

Model 3: model 5 plus adjusted self-rate financial status

[†]Women were not adjusted for activities of daily living in the models since it is highly correlated with cooking frequency



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Gender differences in longevity in free-living older adults who eat-with-others: a prospective study in Taiwan

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TITLE PAGE

Gender differences in longevity in free-living older adults who eat-with-others: a prospective study in Taiwan

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ABSTRACT

Objectives: Social activities such as 'eating-with-others' can positively affect the ageing process. We investigated the gender-specific association between eating arrangements and risk of all-cause mortality among free-living older adults.

Setting: A representative sample from the elderly Nutrition and Health Survey in Taiwan during 1999-2000.

Participants: Some 1,894 participants (955 men and 939 women) who aged ≥65 and completed eating arrangement question as well as confirmed survivorship information.

Primary and secondary outcome measures: Eating arrangements, health condition, and 24-hour dietary recall information were collected at baseline. We classified eating arrangements as the daily frequency of eating-with-others (0–3). Survivorship was determined by the National Death Registry until the end of 2008. Cox proportional-hazards regression was used to assess the association between eating-with-others and mortality risk.

Results: Overall, 63.1% of men and 56.4% of women ate with others 3 times a day. Both men and women who ate with others were more likely to have higher meat and vegetable intakes, and greater dietary quality than those who ate alone. The hazard ratios (HRs) (95% CI) for all-cause mortality when eating-with-others 2 and 3 times daily were 0.46 (0.28–0.61), 0.67 (0.52–0.88) in men and 0.68 (0.42–1.11), 0.86 (0.64–1.16) in women, compared with those who ate alone. Multivariable HRs (95% CI) were 0.43 (0.25–0.73), 0.63 (0.41–0.98) in men and 0.68 (0.35–1.30), 0.69 (0.39–1.21) in women. With further adjustment for financial status, HR was reduced by 54% in men who ate with others twice a day. Pathway analysis shows this to be dependent on improved dietary quality by eating-with-others.

Conclusions: Eating-with-others is an independent survival factor in older men. To providing a social environment which encourages eating-with-others may benefit survival of older people, especially for men.

Key words: elderly, diet, mortality, social activities

STRENGTHS AND LIMITATIONS OF THIS STUDY

- Use of a representative free-living Taiwanese cohort with 10 years' follow-up for survival.
- Study design provided an understanding of eating arrangements for older adults in a community setting.
- A comprehensive assessment of the gender-specific associations between eating-with-others and mortality for older adults.
- The frequency, but not duration of time spent eating alone or eating-with-others was considered.
- Participants were mainly of Chinese ethnicity from Taiwan so that the generalisability of findings may be limited.

INTRODUCTION

Social engagement, such as interpersonal relations (e.g., contact and transactions with friends), exchange of information, and receiving and providing emotional support, is a key component of healthy ageing, besides avoiding disease and maintaining physical and cognitive functions.[1] However, opportunities to interact are frequently reduced after retirement because of factors such as loss of physical capacity, loss of mobility, and solitary living.

The word "Meal" means the event of eating and what is eaten. For this reason, social interaction is considered one of the criteria for a meal.[2] Numerous countries offer nutritional programs, such as congregate meals or meals-on-wheels programs, to encourage eating in a social setting.[3] The inverse correlation between eating-with-others and risk of depression has been studied extensively.[4-7] Additionally, eating alone can be analyzed as a separate risk factor from living alone with regard to depression or depressive symptoms.[5 6] Eating-with-others can potentially improve dietary quality, variety, and energy intake through social facilitation.[8 9] Depression and poor dietary quality increase the risk of chronic disease and mortality in older adults.[10 11] Solitary eating has been associated with a higher risk of mortality among small cohorts of elders in Botswana and the United States.[12 13] But, it is unclear whether the daily frequency of eating-with-others is associated with survivorship.

Gender is also a factor in the quality of older people's lives; for example, women frequently exhibit more health-seeking behavior.[14 15] Yet men face higher risks of depression after widowhood than do women.[16] Exploring the gender-specific associations between solitary eating and mortality among older adults is potentially of public health value.

Providing simple, achievable steps for healthy ageing can prolong life, maintain quality of life over an extended duration, and limit physical deterioration, all of which are beneficial to public health. The purpose of this study was, therefore, to evaluate whether the daily frequency of eating-with-others is associated with all-cause mortality in a representative, free-living,

Taiwanese cohort of older men and women.

SUBJECTS AND METHODS

Participants

Participants aged 65 and over were recruited from the Elderly Nutrition and Health Survey in Taiwan during 1999–2000. The details of the survey design and sampling method have been published elsewhere.[17] In total, 1,937 older people completed face-to-face interviews with trained interviewers. We excluded 40 participants with incorrect identification or incorrect identity numbers and those who did not provide relevant or required information. After which 1,894 participants (955 men and 939 women) remained in the study. Trained interviewers collected data on sociodemographics, dietary habits and intake, and disease history. All participants signed informed consent forms prior to being interviewed. This project was approved by the Ethics Committees of the National Health Research Institute and Academia Sinica, Taiwan.

Eating arrangement

Eating arrangements were assessed by asking participants whether they usually ate breakfast, lunch, and dinner with others. Their responses were recorded as one of the following four options: eat alone, eat with spouse, eat with children or relative(s), and eat with friend(s) or neighbor(s). We then classified the eating arrangements as eating-with-others 0 (eat alone), 1, 2, 3 times a day.[18] Information was also obtained about the person responsible for meal preparation.

Dietary assessment

Information on frequency of dietary intake was collected using a validated simplified food

frequency questionnaire.[19] Dietary quality and nutritional intake were measured through one-day 24-hour dietary recall. The dietary quality was evaluated using the dietary diversity score (DDS), which is based on the consumption of a half serving of the following six food groups daily: grains; meat, fish, or eggs; dairy; vegetables; fruits; and oil or fat. The DDS score ranges from 0 to 6, with a higher score representing higher dietary quality. The method of nutrient intake calculation is described elsewhere.[10]

Other variables

Participants were also asked how frequently they cooked or aided with cooking (excluding ready-to-eat meals), and their responses were recorded as never, sometimes, often, or usually. Participants were then asked how many people they lived with. The response "0" was defined as living alone.

Health-related quality of life was measured by a 36 item Short Form (SF-36) in a validated traditional Chinese version. A total of 8 dimensions of health, included physical functioning, role limitations due to physical problems, mental health, role limitations due to emotional problems, social function, bodily pain, vitality and general health. The score was calculated by the norm-based scoring system (μ=50, σ=10) and standardised. Higher scores indicated a better quality of life.[20]

Disability was evaluated by activities of daily living (ADL) which included 9 questions about self-care task difficulty in an older adult's daily life. We used bioelectrical impedance analysis to measure muscle mass. The skeletal muscle mass index was used to determine sarcopenia status, calculated with the following equation:[21]

$$[0.401 \times (\text{height}^2/\text{resistance}) + (3.825 \times \text{gender}) - (0.071 \times \text{age}) + 5.102]/\text{height}^2$$

where height is measured in metres, resistance in Ohms, and age in years; men = 1 and women = 0.

The Charlson comorbidity index was used to assess multi-morbidity.[22] Cognitive function was assessed by a validated Short Portable Mental Status Questionnaire (SPMSQ) in Chinese which included 10 questions about orientation in time and place, personal history, long-term and short-term memory and calculation. More than or equal to three erroneous responses was regarded as cognitive impairment.[23]

Outcome ascertainment

National Death Registry data were obtained from Taiwan's Ministry of Health and Welfare. We linked the NAHSIT dataset to the National Death Registry dataset using the participant ID to determine survival rates. Follow-up time was calculated from date of interview to date of death or until December 31, 2008.

Statistical analysis

Categorical variables and continuous variables were presented as n (%) or mean ± standard errors (SE). Chi-square and ANOVA were used to determine the association between eating arrangements and baseline characteristics for categorical or continuous variables, respectively. The Cox proportional-hazards regression model was used to evaluate the association between daily frequency eating-with-others and risk of all-cause mortality. Since the interaction between eating arrangements and gender was significant (p=0.0093), we used gender-specific analyses. Additional factors were age, education level (illiterate, primary school, high school and above), marital status (married, bereaved, other), region (Hakka, mountains, Eastern Taiwan, Penghu, Northern Taiwan 1–3, Central Taiwan 1–3, Southern Taiwan 1–3), living arrangement (live alone, live with others), BMI (<18.5, 18.5–23.9, 24.0–26.9, ≥27), DDS (≤3, 4, 5, 6), cooking frequency (never, sometimes, often, frequently), appetite status (good, fair, poor), ADL and self-rate financial statue (more than enough, just enough, not enough). All

data analyses were performed using SAS 9.2 and SUDAAN 9.0 to adjust for the design effect of sampling.

To explore the pathways which might connect eating-with-others to survival, we have considered the intermediates of dietary quality (DDS), physical functioning, mental health, and general health. The first linkage, using continuous variables, has been assessed by Pearson's partial correlation coefficients. The second linkage to risk of mortality, as coefficients, has been assessed by the Aalen additive hazards model.[24]

RESULTS

In total, 63.1% of men and 56.4% of women ate with others 3 times a day. For both genders, those who ate with others were more likely to be younger, married, better financial status, living with others, and less cooking than were those who ate alone. Men who ate alone had significantly higher ADLs (p=0.004) and cognitive impairment (p=0.005) than those who ate with others. (Table 1)

Table 2 presents the dietary quality and food intakes for daily frequency of eating-with-others by gender. Those who ate alone had a poor dietary quality (DDS $\leq$3), compared to those who ate with others 3 times daily. Men who ate alone ate less meat (1.02 vs. 1.30 times/d) and vegetables (1.90 vs. 2.47 times/d) than did those who ate with others 3 times a day ($p<0.05$). Women who ate with others 3 times a day tended to eat more meat (1.13 vs 0.81 times/d), seafood (0.99 vs. 0.70 times/d), eggs (0.38 vs. 0.23 times/d), and vegetable (2.52 vs. 2.09 times/d) intake than did those who ate alone ($p<0.05$). Further, women who ate alone had lower fat (24.7 vs. 28.9 g/1000 kcal/d) intakes, but higher carbohydrate (155 vs. 144 g/1000 kcal/d) intakes compared with those who ate with others ($p<0.05$). Regarding meals, around 58% to 60% of men and 68% to 74% of women prepared meals by themselves when eating alone. Men were more likely to eat out when eating-with-others once a day compared

with women.

Men who ate with others twice per day have significantly high physical functioning compared with other groups (p=0.044). For women, who ate with others once per day have higher physical functioning (50.7 vs. 45.2) and role limitations due to physical problem (51.4 vs. 46.1) compared with those who ate alone. (Table 3)

Table 4 presents the association between daily frequency eating-with-others and risk of all-cause mortality by gender. In the crude model, the HRs (95% CI) of risk of all-cause mortality for who ate with others 2 or 3 times a day were 0.42 (0.28–0.61), 0.67 (0.52–0.88) in men and 0.68 (0.42–1.11), 0.86 (0.64–1.16) in women compared with those who ate alone, respectively. When adjusted for age, education, marital status, region, living arrangement, cooking, appetite status, ADL, DDS, BMI, the HRs (95% CI) were 0.43 (0.25–0.73), 0.63 (0.41–0.98) for men and 0.68 (0.35–1.30), 0.69 (0.39–1.21) for women who ate with others 2 or 3 times a day. With further adjustment for financial status, the risk of mortality is reduced by 54% (HR: 0.46, 95% CI: 0.28–0.77) and 44% (HR: 0.66, 95% CI: 0.43–1.02) for men who ate with others 2 or 3 times a day.

The pathway analyses are shown in Figure 1. For men, there are significant positive associations between eating-with-others frequency and dietary quality (DDS) (p=0.006) as well as mental health (p=0.0009). In turn, better dietary quality (p<0.0001) is associated with less mortality risk, as are physical functioning (p<0.0001) and general health (p=0.007). For women, eating-with-others is not associated with any of dietary quality, physical functioning, mental health or general health; however, dietary quality (p=0.0004) and physical functioning (p<0.0001) are inversely associated with mortality risk, while mental health (p=0.043) is positively associated.

DISCUSSION

This study explored the gender-specific associations between eating arrangement and risk of mortality by observing a population-representative older adult cohort with a 10-year follow-up in an Asian country. Eating-with-others was inversely associated with risk of mortality, more evident in men than in women.

Food intake when eating-with-others

Eating-with-others has numerous beneficial effects on health. A randomized controlled trial at a Dutch nursing home found that family-style meals that included the presence of others increased the energy intake and reduced the prevalence of malnutrition. Those who ate with others ate more than those who ate alone. Social eating may stimulate intake through extension of meal duration and improved ambiance.[8] The presence of others in the household did not affect energy intake, but the presence of others during mealtime did, with an average of 114 calories more per meal than those who ate alone.[25] Eating socially also improved dietary quality and diversity.[7 9] However, the present study shows that after control for dietary quality in the model, eating-with-others and mortality remains associated. A possible reason for this is that solitary eating is often associated with depression,[4-6] in turn associated with mortality. However, there may be value in solitude itself which would be an alternative interpretation of the difference we have found in mortality risk reduction between eating twice and three times a day with others by men.

Eating-with-others and mortality

Our findings are consistent with several studies from Western countries. The Nutrition Screening Initiative (NSI) checklist, a tool for malnutrition screening and awareness in older adults in the US, asks questions regarding solitary eating. In a cohort study with 581 community-dwelling older adults, who ate more than 17 meals alone per week, exhibited a

2.07-fold higher risk of mortality (RR=2.07, 95% CI=1.49–2.86) over an 8–12-year period.[13] Another study in Bostwana found that older adults who ate alone had a higher risk of death (OR=6.7, 95% CI=2.2–20.0).[12] But, gender effect was unknown in these studies.

Eating alone and gender

In the present study, men who ate with others had a lower risk of mortality than did those who ate alone, for several probable reasons. Men who ate with others had better dietary quality and a higher vegetable intake than those eating alone. We also found that men who ate alone were more likely to eat out, not prepare meals by themselves, and frequently skip meals than did women. A Japanese cohort study discovered that men who ate alone were more likely to be underweight and skip meals and less likely to eat fruits and vegetables.[9] Underweight older adults with poor dietary quality and low fruit and vegetable intakes have been associated with a higher risk of mortality.[10 26] Furthermore, in our study, eating out is often associated with high-fat foods with poor quality. Men who were solitary eaters had low carbohydrate, protein, dietary fiber, and other nutrient intakes, but a higher fat intake than those who ate with others, although the differences were non-significant.

Compared with Japan,[9] in our study men have a higher rate of solitary eating, but women have a lower rate. Taiwanese men who eat alone are more likely to be unmarried or live separately from their spouse. We found that the eating companionship of men who ate with others was usually their spouse or children rather than friends or neighbours (data not shown). Davis et al. found that dietary patterns of older men had stronger associations with living arrangements than did those of older women.[27] Cooking itself is a physical activity and a cognitive function,[28] and in Taiwanese culture women are more likely to prepare meals. Men eat out or buy ready-to-eat food more than they cook. In this study, men (47.0%) cooked less than did women (63.9%) when eating alone (Table 1). Men who ate alone shopped more than

did women who ate alone (27.6% vs. 9.6%).

It is also possible that what has been observed as a link between eating-with-others by men and survival is part of a bigger picture of the role of marriage and men living with a partner in their health outcomes and survival. It is well-documented that men who live with a female partner live longer than those who do not.[29 30] This could be for any one or more of several reasons which include having a carer, companionship or sharing of duties. A correlation matrix (Supplementary table 1) shows that the greatest correlations with eating-with-others are for marital status (positive), living alone (negative), and cooking frequency (negative). In all three, the magnitude of the relationships is stronger for men. These covariates are included in our models. We have identified marital status and cooking as potential explanators for the difference in HRs between eating-with-others twice or three times a day by men.

Pathways from eating-with-others to survival

For men but not women, pathway analyses indicate that dietary quality, assessed as dietary diversity, provides a potential connection between the social aspect of eating-with-others and survival (Figure 1). This underscores the likely basic importance of nutritional factors in life-long health, but draws attention to the social as well as the biomedical role of food in health. For men, on pathway analysis, eating-with-others is associated with better mental health. Since pathway analysis requires that all independent variables are continuous, this may have resulted in an absence of a significant direct association of eating-with-others with mortality due to its frequency not being linearly related to mortality; this contrasts with the survival analyses by Cox regression (Table 4). In addition, by pathway analysis, each of physical functioning and general health are themselves important in the prediction of mortality risk in men. It remains conceivable that the dietary quality that men achieve,

irrespective of eating-with-others, plays a role in each of physical functioning and general health, which is evident in this population.[10 20]

In the case of women, dietary quality directly and favourably predicts survival, but this connection is not found to be dependent on eating-with-others. Perhaps women can achieve the biomedical benefit of survival through diet without the need for its social function. In addition, women have a more favourable survival with better physical functioning. Somewhat surprisingly, better mental health is unfavourably associated with survival, although this is weakly significant. It is possible that confounders that have not been considered in this pathway analysis might account for this mental health association with mortality in older women. For example, in devoting themselves to the care of others, or in dealing successfully with a relative socio-economic disadvantage in widowhood, a sense of wellbeing may obtain, while health adversity supervenes.

Limitations

There are some limitations to this study. First, since the study participants were elderly, it can be expected that a change in their eating arrangements would take place through time as family and health circumstances change. Given that this is a single point survey (1999-2000), varied follow-up times may alter the findings. However, we have performed analyses with several follow-up times (<2, <4, <6 and ≥6 years) or the exclusion of events in the first and second years (data not shown). For men, the point estimates for HRs eating-with-others twice a day are consistently <1.00. But for women, low HRs of 0.15 are seen for eating-with-others once a day in the first two years of observation, although not beyond. This does not change our conclusions with the 10-year survival analysis. Second, the association may be affected by the duration of time spent eating alone or eating-with-others, which was not considered. Third, in Taiwanese society, older people are more likely to live with and depend on their families, so

the culturally specific nature of this study may limit its applicability elsewhere. The study should be considered within a Taiwanese (of perhaps a broader Asian) context. As with cohort studies in general, there may have been confounders not considered which might have explained the associations presented. The study itself, however, has sought to consider the circumstances of eating which are usually neglected in the exploration of food and nutrient health relationships. The pathway analyses are an attempt to encompass more of the explanatory models for these relationships by way of inclusion of physical, mental and general health. The gender differences which are now recognised here and in other reports for the respective health roles of dietary quality on the one hand, and with whom the food is consumed on the other, are a challenge to more gender comprehensive public health policy.

Conclusions

Eating socially may benefit survival in elderly men through the adjunct of dietary quality; it is also positively associated with men's mental health. For women, dietary quality is associated with survival advantage which is not apparently dependent on eating-with-others. The relative gender advantage in longevity that women have in this population is not adequately explained in the present study, except that they are likely to be the ones who eat with men who benefit from this social role of food. Thus, for men and women, the provision of a healthy social environment which increases social interactions should improve health outcomes.

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None of the authors has any conflicts of interest to declare.

AUTHOR'S CONTRIBUTION

YCH, HLC, MLW and MSL designed the study; YCH, HLC and YTCL performed statistical analysis; YCH, MLW, YTCL, and MSL wrote the paper; MSL had primary responsibility for the final content.

COMPETING INTERESTS

No author has any conflict of interest in regard to this paper.

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DATA SHARING STATEMENT

No additional data are available.

ETHICS

This project was approved by the Ethics Committees of the National Health Research Institute and Academia Sinica, Taiwan.

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LEGENDS

Figure 1. Pathway analysis for the associations of eating-with-others and all-cause mortality. All values are presented as β coefficients with their p values.

Table 1. The baseline characteristics by daily frequency for eating-with-others

Variables	Daily frequency for eating-with-others											
	Men						Women					
	Total	0	1	2	3	p value	Total	0	1	2	3	p value
N		142	57	126	630			174	79	140	546	
%		14.3	6.96	15.6	63.1			17.8	10.2	15.7	56.4	
Median of follow-up (yrs)		8.17	8.28	8.76	8.67			8.55	8.89	8.75	8.74	
Age at baseline (yrs)	72.9±0.33	74.9±0.65	71.8±0.74	72.4±0.73	72.7±0.44	0.042	73.4±0.44	75.3±0.76	72.9±0.65	72.9±0.88	73.0±0.39	0.020
Education						<0.0001						0.963
Illiterate	18.8	24.2	16.7	8.8	20.3		56.0	57.5	55.6	52.3	56.6	
Some up to primary school	46.6	52.3	43.5	48.4	45.2		32.3	32.5	32.0	33.8	31.9	
High school and above	34.7	23.5	39.9	42.8	34.5		11.7	10.0	12.4	13.8	11.5	
Marital status						<0.0001						<0.0001
Married	78.6	36.1	48.2	75.0	92.5		49.48	15.5	19.6	37.8	68.8	
Bereaved	14.3	37.8	38.8	17.5	5.43		48.12	80.6	71.1	60.7	30.3	
Others	7.15	26.1	13.0	7.55	2.11		2.40	3.87	9.32	1.56	0.95	
Live alone	13.7	60.4	0.00	9.67	1.47	<0.0001	10.3	49.4	6.43	2.91	0.42	<0.0001
Whether enough money						0.030						0.001
More than enough	78.4	71.8	79.9	85.8	77.8		75.0	64.1	63.1	78.3	79.5	
Just enough	19.2	21.7	20.2	13.0	20.1		21.0	28.7	28.8	21.0	17.2	
Not enough	2.46	6.52	0.00	1.26	2.14		4.01	7.23	8.13	0.70	3.25	
Smoker	65.7	70.5	82.0	63.9	63.2	0.078	4.92	2.44	2.55	5.34	6.01	0.171
Appetite status						0.232						0.112
Good	38.5	33.0	45.0	36.6	39.4		30.4	24.9	42.9	31.7	29.5	
Fair	55.5	62.5	41.5	59.4	54.5		59.4	57.2	48.8	61.5	61.4	
Poor	6.07	4.54	13.5	4.09	6.08		10.2	17.9	8.34	6.87	9.14	
Body mass index (kg/m^2)	23.3±0.15	22.9±0.46	23.2±0.64	23.2±0.33	23.3±0.17	0.738	23.9±0.25	23.3±0.56	25.1±0.43	24.5±0.50	23.8±0.28	0.0002
< 18.5	7.07	11.2	10.4	7.53	5.66		7.01	8.07	0.00	3.83	8.72	
18.5–23.9	52.5	54.1	53.4	50.6	52.6		44.0	51.0	39.6	40.9	43.6	

24.0–26.9	28.0	19.0	19.9	34.0	29.2		27.8	24.7	34.1	25.3	28.1	
≥ 27.0	12.5	15.7	16.3	7.91	12.6		21.3	16.3	26.3	30.0	19.6	
Physical activity (MET/day)						0.173						0.017
<1.5	51.6	45.3	44.0	51.2	54.0		61.1	60.5	51.0	52.9	65.4	
1.5–2.9	11.3	14.3	17.9	14.2	9.17		11.8	14.3	6.16	14.0	11.4	
≥3	37.1	40.4	38.1	34.7	36.8		27.1	25.2	42.8	33.1	23.2	
Shopping						0.239						0.037
<1/wk	43.8	34.2	44.5	45.9	45.5		54.9	65.3	46.6	50.9	54.3	
1/wk	12.7	13.5	15.2	13.0	12.2		13.6	10.2	14.8	18.4	13.1	
1–2/wk	23.3	24.7	21.0	19.6	24.2		19.8	14.9	24.7	22.0	19.8	
Everyday	20.2	27.6	19.3	21.6	18.3		11.7	9.63	13.9	8.74	12.9	
Current cooking activity						<0.0001						0.004
Never	58.4	33.2	44.1	58.1	65.8		26.8	24.1	12.1	31.5	29.1	
Sometimes	20.3	13.1	19.2	24.8	20.8		13.2	5.10	9.1	16.0	15.8	
Often	6.83	6.63	11.4	9.63	5.66		10.5	6.94	20.0	12.6	9.23	
Usually	14.5	47.0	25.2	7.46	7.69		49.5	63.9	58.8	39.9	45.9	
Activities of daily living	0.33±0.05	0.52±0.18	0.19±0.15	0.07±0.05	0.36±0.07	0.004	0.57±0.08	1.18±0.34	0.27±0.13	0.28±0.17	0.50±0.10	0.088
Skeletal muscle mass index (kg/ m^2)	12.3±0.12	12.0±0.27	12.2±0.29	12.0±0.20	12.5±0.13	0.149	9.28±0.12	9.14±0.22	9.52±0.20	9.32±0.17	9.29±0.15	0.213
Charlson comorbidity index	4.71±0.20	5.20±0.48	4.22±0.39	4.85±0.61	4.62±0.20	0.365	4.77±0.21	5.06±0.51	4.74±0.59	4.21±0.29	4.84±0.24	0.142
Self-perceived health status						0.400						<0.0001
Excellent	4.55	7.12	7.46	1.23	4.47		2.58	2.88	0	3.14	2.80	
Very good	19.9	16.5	13.8	29.9	18.9		15.7	10.7	24.3	14.1	16.0	
Good	21.4	25.8	19.0	17.3	21.8		16.1	11.8	9.85	17.7	18.2	
Fair	41.1	38.2	40.3	40.7	41.9		48.3	47.9	56.7	50.4	46.2	
Poor	13.1	12.4	19.5	10.9	13.1		17.4	26.7	9.25	14.7	16.8	
Cognitive impairment	8.81	12.6	1.82	3.10	10.2	0.005	27.4	30.9	25.9	30.4	25.8	0.751

All data weighted for unequal probability of sampling design by SUDAAN. Categorical variables are presented as n (%), and continuous variables are presented as mean±SE.

ANOVA and chi-square were used for continuous and categories variables to test difference between the groups by gender.

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Table 2. Food, nutrient intakes and daily frequency of eating-with-others by gender

	Daily frequency for eating-with-others									
	Men					Women				
	0	1	2	3	p value	0	1	2	3	p value
Food preparation, %										
Skipping meals	11.2	16.5	5.75	2.96	0.008	6.54	8.45	4.76	4.27	0.370
Who prepared breakfast?					<0.0001					0.003
Self	57.6	45.7	37.0	12.7		74.0	76.2	61.3	57.2	
Others	28.6	36.4	56.1	85.8		23.9	20.7	36.1	41.5	
Eating out	13.8	17.9	6.96	1.52		2.14	3.12	2.62	1.35	
Who prepared lunch?					<0.0001					0.0001
Self	59.0	40.8	11.3	9.07		68.1	74.2	48.0	53.1	
Others	31.3	34.9	85.0	89.0		26.3	18.1	50.0	45.2	
Eating out	9.72	24.3	3.66	1.90		5.59	7.73	1.96	1.63	
Who prepared dinner?					<0.0001					0.009
Self	60.0	25.0	6.20	8.52		67.7	60.1	44.6	51.4	
Others	32.9	74.0	92.1	90.7		30.2	39.9	55.4	48.1	
Eating out	7.05	1.03	1.73	0.76		2.11	0.00	0.00	0.51	
If you need to prepare meals for yourself, who gets the food?					<0.0001					0.118
Never prepare	6.21	15.8	9.38	9.32		8.37	1.67	5.24	6.60	
Self	61.2	23.4	21.2	18.6		60.2	67.4	48.2	48.4	
Others	32.6	60.8	69.5	72.1		31.4	31.0	46.6	45.0	
Dietary diversity score, mean±SE	4.27±0.11	4.13±0.17	4.57±0.11	4.61±0.06	0.003	4.28±0.13	4.32±0.14	4.69±0.10	4.46±0.06	0.009
≤3 (%)	24.1	22.1	12.2	12.1	0.010	30.2	20.7	8.05	17.5	0.001
4 (%)	30.0	41.4	30.2	32.4		24.1	31.2	31.5	31.3	
5 (%)	35.4	28.4	39.6	35.8		25.1	31.7	42.8	34.8	

6 (%)	10.8	8.13	18.0	19.7		20.7	16.4	17.6	16.4	
Food intake other than cereal (times/d), mean±SE										
Dairy	0.57±0.07	0.40±0.09	0.65±0.08	0.62±0.05	0.116	0.80±0.08	0.89±0.14	0.74±0.09	0.72±0.05	0.480
Meat	1.02±0.09	1.98±0.08	1.59±0.19	1.30±0.07	0.001	0.81±0.15	0.86±0.16	1.20±0.16	1.13±0.08	0.017
Seafood	0.86±0.18	0.93±0.12	1.08±0.12	0.99±0.08	0.524	0.70±0.10	0.92±0.12	0.91±0.09	0.99±0.07	0.026
Egg	0.44±0.08	0.39±0.05	0.46±0.05	0.46±0.03	0.687	0.23±0.03	0.36±0.04	0.36±0.03	0.38±0.03	0.003
Soy	0.48±0.09	0.43±0.06	0.47±0.06	0.45±0.04	0.824	0.39±0.06	0.50±0.10	0.61±0.07	0.51±0.05	0.063
Vegetable	1.90±0.18	1.84±0.13	2.57±0.13	2.47±0.12	0.004	2.09±0.14	2.28±0.13	2.35±0.14	2.52±0.14	0.011
Fruit	0.99±0.11	0.93±0.13	1.21±0.09	1.19±0.04	0.073	0.91±0.10	0.90±0.07	1.21±0.10	1.07±0.06	0.058
Total energy intake (kcal), mean±SE	1833±100	1849±123	1871±118	1815±77.4	0.940	1327±92.6	1518±126	1500±58.7	1521±84.3	0.206
Nutrient density (/1,000 kcal), mean±SE										
Carbohydrate (g)	132±4.79	137±5.21	139±2.58	139±2.71	0.438	155±3.55	143±5.63	144±3.31	144±1.82	0.028
Dietary fiber (g)	11.2±0.79	11.7±0.87	12.4±0.75	11.7±0.45	0.653	15.5±2.05	14.1±1.44	14.0±1.02	12.7±0.57	0.416
Fat (g)	32.1±1.42	30.5±2.15	30.2±1.28	29.5±0.82	0.377	24.7±1.13	29.7±2.30	29.2±1.50	28.9±0.85	0.002
Protein (g)	41.9±1.80	43.3±2.52	41.5±1.34	43.2±1.16	0.690	41.6±1.77	42.1±2.06	42.8±1.32	41.8±1.27	0.923
Vitamin B-1 (mg)	0.63±0.06	0.78±0.07	0.69±0.04	0.70±0.03	0.645	0.71±0.08	0.69±0.05	0.76±0.07	0.66±0.03	0.449
Vitamin B-2 (mg)	0.84±0.06	0.88±0.12	0.78±0.06	0.81±0.04	0.801	1.02±0.07	1.11±0.14	1.05±0.09	0.85±0.04	0.107
Vitamin B-6 (mg)	0.73±0.07	0.82±0.09	0.75±0.05	0.72±0.03	0.586	0.65±0.05	0.81±0.08	0.73±0.03	0.71±0.03	0.421
Vitamin C (mg)	92.5±12.2	88.4±12.8	87.5±8.69	90.6±6.18	0.984	110±9.32	103±11.5	131±20.0	105±7.72	0.597
Calcium (mg)	382±26.2	338±41.7	336±21.0	365±16.3	0.353	536±43.0	455±42.4	483±41.7	432±19.8	0.166
Magnesium (mg)	139±7.34	141±12.1	143±6.63	145±3.84	0.907	167±9.06	157±7.87	159±9.59	147±4.55	0.142

All data weighted for unequal probability of sampling design by SUDAAN.

ANOVA and chi-square were used for continuous and categories variables to test difference between the groups by gender.

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Table 3. Health-related quality of life (SF-36) according to daily frequency eating-with-others by gender

	Daily frequency eating-with-others									
	Men					Women				
	0	1	2	3	p value	0	1	2	3	p value
General health	52.8±1.18	52.0±1.49	52.9±1.10	51.5±0.50	0.538	47.1±0.99	48.6±1.23	49.7±1.24	49.0±0.84	0.211
Mental health	51.4±0.91	49.3±1.88	52.3±1.13	52.5±0.50	0.222	47.8±1.30	47.3±1.45	48.8±1.27	49.2±1.02	0.542
Physical functioning	51.1±1.16	50.4±1.26	53.3±0.68	51.5±0.65	0.044	45.2±0.96	50.7±0.97	48.2±1.03	47.0±0.64	0.002
Body pain	51.2±1.20	51.5±1.63	52.8±1.04	51.9±0.68	0.529	46.5±1.08	47.4±1.20	49.5±1.00	48.0±0.69	0.112
Role limitations due to emotional problems	50.0±1.19	47.7±1.69	51.5±0.93	51.2±0.63	0.160	47.5±1.16	50.8±1.51	49.6±1.13	49.3±0.86	0.354
Role limitations due to physical problems	50.2±1.36	49.5±1.31	52.1±1.01	51.4±0.67	0.254	46.1±1.03	51.4±1.28	48.7±1.55	49.7±0.87	0.005
Social function	50.0±1.22	49.4±1.71	51.9±0.99	50.9±0.67	0.262	48.2±1.17	48.6±1.31	50.0±1.31	49.0±0.71	0.698
Vitality	51.0±1.32	49.4±1.76	51.7±1.02	51.8±0.68	0.591	47.1±0.95	49.2±1.72	48.1±1.45	48.1±0.75	0.553

All data weighted for unequal probability of sampling design by SUDAAN.
ANOVA was used for continuous and categories variables to test difference between the groups by gender.

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Table 4. Gender-specific hazard ratios (95% CI) of association between eating-with-others and risk of mortality in older adults

	Daily frequency of eating-with-others							
	Men				Women			
	0	1	2	3	0	1	2	3
Deceased/survival, n	75/67	26/31	37/89	248/382	60/114	20/59	36/104	196/350
Crude model	1.00	0.90 (0.60–1.35)	0.42*** (0.28–0.61)	0.67** (0.52–0.88)	1.00	0.53 (0.27–1.05)	0.68 (0.42–1.11)	0.86 (0.64–1.16)
Model 1	1.00	1.12 (0.71–1.78)	0.48** (0.31–0.74)	0.76 (0.57–1.03)	1.00	0.54 (0.24–1.23)	0.89 (0.53–1.49)	1.07 (0.77–1.49)
Model 2†	1.00	0.76 (0.37–1.56)	0.43** (0.25–0.73)	0.63* (0.41–0.98)	1.00	0.56 (0.29–1.07)	0.68 (0.35–1.30)	0.69 (0.39–1.21)
Model 3†	1.00	0.78 (0.39–1.55)	0.46** (0.28–0.77)	0.66 (0.43–1.02)	1.00	0.54 (0.27–1.06)	0.70 (0.36–1.36)	0.72 (0.40–1.27)

Data were weighted for unequal probability of sampling design by SUDAAN and estimated HR (95% CI) by using the Cox proportional-hazard model.

Model 1: adjusted for age

Model 2: adjusted for age, education, strata, live alone, cook frequency, marital status, appetite status, dietary diversity score, activities of daily living and body mass index

Model 3: model 2 plus adjusted self-rate financial status

†Women were not adjusted for activities of daily living in the models since it is highly correlated with cooking frequency.

*p<0.05; **p<0.01; ***p<0.001

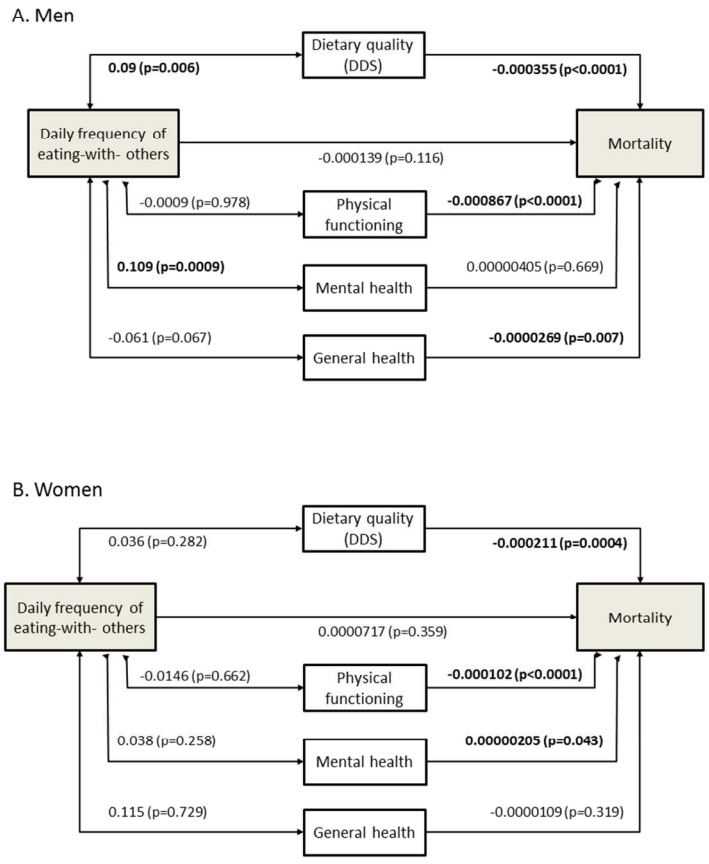

Figure 1. Pathway analysis for the associations of eating-with-others and all-cause mortality. All values are presented as β coefficients with their p values.

297x420mm (300 x 300 DPI)

Supplementary table 1. Spearman rank correlation coefficients between daily frequency of eating with others and co-variables

	Spearman rank correlation coefficients	
	Men	Women
Education – higher	0.067*	0.037
Marital status – married	0.522***	0.460***
Dietary diversity score – higher	0.092**	0.033
Body mass index – higher	0.037	0.025
Age – older	-0.092**	-0.127**
Live alone	-0.648***	-0.592***
Cooking frequency – more	-0.407***	-0.157***
Appetite status – poor	-0.035	-0.01
Activities of daily living – more difficulties	-0.037	-0.087**
Self-rate financial status – not enough	-0.066*	-0.124**

*p<0.05; **p<0.001; ***p<0.0001

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4-5
Methods			
Study design	4	Present key elements of study design early in the paper	5-7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5-7
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	5, 7
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5-7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5-7
Bias	9	Describe any efforts to address potential sources of bias	13
Study size	10	Explain how the study size was arrived at	N/A
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5, 6-7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7-8
		(*b*) Describe any methods used to examine subgroups and interactions	7
		(*c*) Explain how missing data were addressed	5
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	5
		(*e*) Describe any sensitivity analyses	13

Continued on next page

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5
		(b) Give reasons for non-participation at each stage	5
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8-9 (Table 1)
		(b) Indicate number of participants with missing data for each variable of interest	5
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	Table 1
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	Table 4
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9 (Table 4)
		(*b*) Report category boundaries when continuous variables were categorized	7
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	7
Discussion			
Key results	18	Summarise key results with reference to study objectives	10
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14
Generalisability	21	Discuss the generalisability (external validity) of the study results	14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Gender differences in longevity in free-living older adults who eat-with-others: a prospective study in Taiwan

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TITLE PAGE

Gender differences in longevity in free-living older adults who eat-with-others: a prospective study in Taiwan

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ABSTRACT

Objectives: Social activities such as 'eating-with-others' can positively affect the ageing process. We investigated the gender-specific association between eating arrangements and risk of all-cause mortality among free-living older adults.

Setting: A representative sample from the elderly Nutrition and Health Survey in Taiwan during 1999-2000.

Participants: Some 1,894 participants (955 men and 939 women) who aged ≥65 and completed eating arrangement question as well as confirmed survivorship information.

Primary and secondary outcome measures: Eating arrangements, health condition, and 24-hour dietary recall information were collected at baseline. We classified eating arrangements as the daily frequency of eating-with-others (0–3). Survivorship was determined by the National Death Registry until the end of 2008. Cox proportional-hazards regression was used to assess the association between eating-with-others and mortality risk.

Results: Overall, 63.1% of men and 56.4% of women ate with others 3 times a day. Both men and women who ate with others were more likely to have higher meat and vegetable intakes, and greater dietary quality than those who ate alone. The hazard ratios (HRs) (95% CI) for all-cause mortality when eating-with-others 2 and 3 times daily were 0.46 (0.28–0.61), 0.67 (0.52–0.88) in men and 0.68 (0.42–1.11), 0.86 (0.64–1.16) in women, compared with those who ate alone. Multivariable HRs (95% CI) adjusted for sociodemographic, nutritional and "activities of daily living" covariates were 0.43 (0.25–0.73), 0.63 (0.41–0.98) in men and 0.68 (0.35–1.30), 0.69 (0.39–1.21) in women. With further adjustment for financial status, HR was reduced by 54% in men who ate with others twice a day. Pathway analysis shows this to be dependent on improved dietary quality by eating-with-others.

Conclusions: Eating-with-others is an independent survival factor in older men. To providing a social environment which encourages eating-with-others may benefit survival of older

people, especially for men.

Key words: elderly, diet, mortality, social activities

STRENGTHS AND LIMITATIONS OF THIS STUDY

- Use of a representative free-living Taiwanese cohort with 10 years' follow-up for survival.
- Study design provided an understanding of eating arrangements for older adults in a community setting.
- A comprehensive assessment of the gender-specific associations between eating-with-others and mortality for older adults.
- The frequency, but not duration of time spent eating alone or eating-with-others was considered.
- Participants were mainly of Chinese ethnicity from Taiwan so that the generalisability of findings may be limited.

INTRODUCTION

Social engagement, such as interpersonal relations (e.g., contact and transactions with friends), exchange of information, and receiving and providing emotional support, is a key component of healthy ageing, besides avoiding disease and maintaining physical and cognitive functions.[1] However, opportunities to interact are frequently reduced after retirement because of factors such as loss of physical capacity, loss of mobility, and solitary living.

The word "Meal" means the event of eating and what is eaten. For this reason, social interaction is considered one of the criteria for a meal.[2] Numerous countries offer nutritional programs, such as congregate meals or meals-on-wheels programs, to encourage eating in a social setting.[3] The inverse correlation between eating-with-others and risk of depression has been studied extensively.[4-7] Additionally, eating alone can be analyzed as a separate risk factor from living alone with regard to depression or depressive symptoms.[5 6] Eating-with-others can potentially improve dietary quality, variety, and energy intake through social facilitation.[8 9] Depression and poor dietary quality increase the risk of chronic disease and mortality in older adults.[10 11] Solitary eating has been associated with a higher risk of mortality among small cohorts of elders in Botswana and the United States.[12 13] But, it is unclear whether the daily frequency of eating-with-others is associated with survivorship.

Gender is also a factor in the quality of older people's lives; for example, women frequently exhibit more health-seeking behavior.[14 15] Yet men face higher risks of depression after widowhood than do women.[16] Exploring the gender-specific associations between solitary eating and mortality among older adults is potentially of public health value.

Providing simple, achievable steps for healthy ageing can prolong life, maintain quality of life over an extended duration, and limit physical deterioration, all of which are beneficial to public health. The purpose of this study was, therefore, to evaluate whether the daily frequency of eating-with-others is associated with all-cause mortality in a representative, free-living,

Taiwanese cohort of older men and women.

SUBJECTS AND METHODS

Participants

Participants aged 65 and over were recruited from the Elderly Nutrition and Health Survey in Taiwan during 1999–2000. The details of the survey design and sampling method have been published elsewhere.[17] In total, 1,937 older people completed face-to-face interviews with trained interviewers. We excluded 40 participants with incorrect identification or incorrect identity numbers and those who did not provide relevant or required information. After which 1,894 participants (955 men and 939 women) remained in the study. Trained interviewers collected data on sociodemographics, dietary habits and intake, and disease history. All participants signed informed consent forms prior to being interviewed. This project was approved by the Ethics Committees of the National Health Research Institute and Academia Sinica, Taiwan.

Eating arrangement

Eating arrangements were assessed by asking participants whether they usually ate breakfast, lunch, and dinner with others. Their responses were recorded as one of the following four options: eat alone, eat with spouse, eat with children or relative(s), and eat with friend(s) or neighbor(s). We then classified the eating arrangements as eating-with-others 0 (eat alone), 1, 2, 3 times a day.[18] Information was also obtained about the person responsible for meal preparation.

Dietary assessment

Information on frequency of dietary intake was collected using a validated simplified food

frequency questionnaire.[19] Dietary quality and nutritional intake were measured through one-day 24-hour dietary recall. The dietary quality was evaluated using the dietary diversity score (DDS), which is based on the consumption of a half serving of the following six food groups daily: grains; meat, fish, or eggs; dairy; vegetables; fruits; and oil or fat. The DDS score ranges from 0 to 6, with a higher score representing higher dietary quality. The method of nutrient intake calculation is described elsewhere.[10]

Other variables

Participants were also asked how frequently they cooked or aided with cooking (excluding ready-to-eat meals), and their responses were recorded as never, sometimes, often, or usually. Participants were then asked how many people they lived with. The response "0" was defined as living alone.

Health-related quality of life was measured by a 36 item Short Form (SF-36) in a validated traditional Chinese version. A total of 8 dimensions of health, included physical functioning, role limitations due to physical problems, mental health, role limitations due to emotional problems, social function, bodily pain, vitality and general health. The score was calculated by the norm-based scoring system (μ=50, σ=10) and standardised. Higher scores indicated a better quality of life.[20]

Disability was evaluated by activities of daily living (ADL) which included 9 questions about self-care task difficulty in an older adult's daily life. We used bioelectrical impedance analysis to measure muscle mass. The skeletal muscle mass index was used to determine sarcopenia status, calculated with the following equation:[21]

$$[0.401 \times (\text{height}^2 / \text{resistance}) + (3.825 \times \text{gender}) - (0.071 \times \text{age}) + 5.102] / \text{height}^2$$

where height is measured in metres, resistance in Ohms, and age in years; men = 1 and women = 0.

The Charlson comorbidity index was used to assess multi-morbidity.[22] Cognitive function was assessed by a validated Short Portable Mental Status Questionnaire (SPMSQ) in Chinese which included 10 questions about orientation in time and place, personal history, long-term and short-term memory and calculation. More than or equal to three erroneous responses was regarded as cognitive impairment.[23]

Outcome ascertainment

National Death Registry data were obtained from Taiwan's Ministry of Health and Welfare. We linked the NAHSIT dataset to the National Death Registry dataset using the participant ID to determine survival rates. Follow-up time was calculated from date of interview to date of death or until December 31, 2008.

Statistical analysis

Categorical variables and continuous variables were presented as n (%) or mean ± standard errors (SE). Chi-square and ANOVA were used to determine the association between eating arrangements and baseline characteristics for categorical or continuous variables, respectively. The Cox proportional-hazards regression model was used to evaluate the association between daily frequency eating-with-others and risk of all-cause mortality. Since the interaction between eating arrangements and gender was significant (p=0.0093), we used gender-specific analyses. Additional factors were age, education level, marital status, region, living arrangement, BMI, DDS, cooking frequency, appetite status, ADL and self-rate financial status. All data analyses were performed using SAS 9.2 and SUDAAN 9.0 to adjust for the design effect of sampling.

To explore the pathways which might connect eating-with-others to survival, we have considered the intermediates of dietary quality (DDS), physical functioning, mental health,

and general health. The first linkage, using continuous variables, has been assessed by Pearson's partial correlation coefficients. The second linkage to risk of mortality, as coefficients, has been assessed by the Aalen additive hazards model.[24]

RESULTS

In total, 63.1% of men and 56.4% of women ate with others 3 times a day. For both genders, those who ate with others were more likely to be younger, married, better financial status, living with others, and less cooking than were those who ate alone. Men who ate alone had significantly higher ADLs (p=0.004) and cognitive impairment (p=0.005) than those who ate with others. (Table 1)

Table 2 presents the dietary quality and food intakes for daily frequency of eating-with-others by gender. Those who ate alone had a poor dietary quality (DDS ≤3), compared to those who ate with others 3 times daily. Men who ate alone ate less meat (1.02 vs. 1.30 times/d) and vegetables (1.90 vs. 2.47 times/d) than did those who ate with others 3 times a day (p<0.05). Women who ate with others 3 times a day tended to eat more meat (1.13 vs 0.81 times/d), seafood (0.99 vs. 0.70 times/d), eggs (0.38 vs. 0.23 times/d), and vegetable (2.52 vs. 2.09 times/d) intake than did those who ate alone (p<0.05). Further, women who ate alone had lower fat (24.7 vs. 28.9 g/1000 kcal/d) intakes, but higher carbohydrate (155 vs. 144 g/1000 kcal/d) intakes compared with those who ate with others (p<0.05). Regarding meals, around 58% to 60% of men and 68% to 74% of women prepared meals by themselves when eating alone. Men were more likely to eat out when eating-with-others once a day compared with women.

Men who ate with others twice per day have significantly high physical functioning compared with other groups (p=0.044). For women, who ate with others once per day have higher physical functioning (50.7 vs. 45.2) and role limitations due to physical problem (51.4

vs. 46.1) compared with those who ate alone. (Table 3)

Table 4 presents the association between daily frequency eating-with-others and risk of all-cause mortality by gender. In the crude model, the HRs (95% CI) of risk of all-cause mortality for who ate with others 2 or 3 times a day were 0.42 (0.28–0.61), 0.67 (0.52–0.88) in men and 0.68 (0.42–1.11), 0.86 (0.64–1.16) in women compared with those who ate alone, respectively. When adjusted for age, education, marital status, region, living arrangement, cooking, appetite status, ADL, DDS, BMI, the HRs (95% CI) were 0.43 (0.25–0.73), 0.63 (0.41–0.98) for men and 0.68 (0.35–1.30), 0.69 (0.39–1.21) for women who ate with others 2 or 3 times a day. With further adjustment for financial status, the risk of mortality is reduced by 54% (HR: 0.46, 95% CI: 0.28–0.77) and 34% (HR: 0.66, 95% CI: 0.43–1.02) for men who ate with others 2 or 3 times a day.

The pathway analyses are shown in Figure 1. For men, there are significant positive associations between eating-with-others frequency and dietary quality (DDS) ($p=0.006$) as well as mental health ($p=0.0009$). In turn, better dietary quality ($p<0.0001$) is associated with less mortality risk, as are physical functioning ($p<0.0001$) and general health ($p=0.007$). For women, eating-with-others is not associated with any of dietary quality, physical functioning, mental health or general health; however, dietary quality ($p=0.0004$) and physical functioning ($p<0.0001$) are inversely associated with mortality risk, while mental health ($p=0.043$) is positively associated.

DISCUSSION

This study explored the gender-specific associations between eating arrangement and risk of mortality by observing a population-representative older adult cohort with a 10-year follow-up in an Asian country. Eating-with-others was inversely associated with risk of mortality, more evident in men than in women.

Food intake when eating-with-others

Eating-with-others has numerous beneficial effects on health. A randomized controlled trial at a Dutch nursing home found that family-style meals that included the presence of others increased the energy intake and reduced the prevalence of malnutrition. Those who ate with others ate more than those who ate alone. Social eating may stimulate intake through extension of meal duration and improved ambiance.[8] The presence of others in the household did not affect energy intake, but the presence of others during mealtime did, with an average of 114 calories more per meal than those who ate alone.[25] Eating socially also improved dietary quality and diversity.[7 9] However, the present study shows that after control for dietary quality in the model, eating-with-others and mortality remains associated. A possible reason for this is that solitary eating is often associated with depression,[4-6] in turn associated with mortality. However, there may be value in solitude itself which would be an alternative interpretation of the difference we have found in mortality risk reduction between eating twice and three times a day with others by men.

Eating-with-others and mortality

Our findings are consistent with several studies from Western countries. The Nutrition Screening Initiative (NSI) checklist, a tool for malnutrition screening and awareness in older adults in the US, asks questions regarding solitary eating. In a cohort study with 581 community-dwelling older adults, who ate more than 17 meals alone per week, exhibited a 2.07-fold higher risk of mortality (RR=2.07, 95% CI=1.49–2.86) over an 8–12-year period.[13] Another study in Bostwana found that older adults who ate alone had a higher risk of death (OR=6.7, 95% CI=2.2–20.0).[12] But, gender effect was unknown in these studies.

Eating alone and gender

In the present study, men who ate with others had a lower risk of mortality than did those who ate alone, for several probable reasons. Men who ate with others had better dietary quality and a higher vegetable intake than those eating alone. We also found that men who ate alone were more likely to eat out, not prepare meals by themselves, and frequently skip meals than did women. A Japanese cohort study discovered that men who ate alone were more likely to be underweight and skip meals and less likely to eat fruits and vegetables.[9] Underweight older adults with poor dietary quality and low fruit and vegetable intakes have been associated with a higher risk of mortality.[10 26] Furthermore, in our study, eating out is often associated with high-fat foods with poor quality. Men who were solitary eaters had low carbohydrate, protein, dietary fiber, and other nutrient intakes, but a higher fat intake than those who ate with others, although the differences were non-significant.

Compared with Japan,[9] in our study men have a higher rate of solitary eating, but women have a lower rate. Taiwanese men who eat alone are more likely to be unmarried or live separately from their spouse. We found that the eating companionship of men who ate with others was usually their spouse or children rather than friends or neighbours (data not shown). Davis et al. found that dietary patterns of older men had stronger associations with living arrangements than did those of older women.[27] Cooking itself is a physical activity and a cognitive function,[28] and in Taiwanese culture women are more likely to prepare meals. Men eat out or buy ready-to-eat food more than they cook. In this study, men (47.0%) cooked less than did women (63.9%) when eating alone (Table 1). Men who ate alone shopped more than did women who ate alone (27.6% vs. 9.6%).

It is also possible that what has been observed as a link between eating-with-others by men and survival is part of a bigger picture of the role of marriage and men living with a partner in their health outcomes and survival. It is well-documented that men who live with a

female partner live longer than those who do not.[29 30] This could be for any one or more of several reasons which include having a carer, companionship or sharing of duties. A correlation matrix (Supplementary table 1) shows that the greatest correlations with eating-with-others are for marital status (positive), living alone (negative), and cooking frequency (negative). In all three, the magnitude of the relationships is stronger for men. These covariates are included in our models. We have identified marital status and cooking as potential explanators for the difference in HRs between eating-with-others twice or three times a day by men.

Pathways from eating-with-others to survival

For men but not women, pathway analyses indicate that dietary quality, assessed as dietary diversity, provides a potential connection between the social aspect of eating-with-others and survival (Figure 1). This underscores the likely basic importance of nutritional factors in life-long health, but draws attention to the social as well as the biomedical role of food in health. For men, on pathway analysis, eating-with-others is associated with better mental health. Since pathway analysis requires that all independent variables are continuous, this may have resulted in an absence of a significant direct association of eating-with-others with mortality due to its frequency not being linearly related to mortality; this contrasts with the survival analyses by Cox regression (Table 4). In addition, by pathway analysis, each of physical functioning and general health are themselves important in the prediction of mortality risk in men. It remains conceivable that the dietary quality that men achieve, irrespective of eating-with-others, plays a role in each of physical functioning and general health, which is evident in this population.[10 20]

In the case of women, dietary quality directly and favourably predicts survival, but this connection is not found to be dependent on eating-with-others. Perhaps women can achieve

the biomedical benefit of survival through diet without the need for its social function. In addition, women have a more favourable survival with better physical functioning. Somewhat surprisingly, better mental health is unfavourably associated with survival, although this is weakly significant. It is possible that confounders that have not been considered in this pathway analysis might account for this mental health association with mortality in older women. For example, in devoting themselves to the care of others, or in dealing successfully with a relative socio-economic disadvantage in widowhood, a sense of wellbeing may obtain, while health adversity supervenes.

Limitations

There are some limitations to this study. First, since the study participants were elderly, it can be expected that a change in their eating arrangements would take place through time as family and health circumstances change. Given that this is a single point survey (1999-2000), varied follow-up times may alter the findings. However, we have performed analyses with several follow-up times (<2, <4, <6 and ≥6 years) or the exclusion of events in the first and second years (data not shown). For men, the point estimates for HRs eating-with-others twice a day are consistently <1.00. But for women, low HRs of 0.15 are seen for eating-with-others once a day in the first two years of observation, although not beyond. This does not change our conclusions with the 10-year survival analysis. Second, the association may be affected by the duration of time spent eating alone or eating-with-others, which was not considered. Third, in Taiwanese society, older people are more likely to live with and depend on their families, so the culturally specific nature of this study may limit its applicability elsewhere. The study should be considered within a Taiwanese (of perhaps a broader Asian) context. As with cohort studies in general, there may have been confounders not considered which might have explained the associations presented. The study itself, however, has sought to consider the

circumstances of eating which are usually neglected in the exploration of food and nutrient health relationships. The pathway analyses are an attempt to encompass more of the explanatory models for these relationships by way of inclusion of physical, mental and general health. The gender differences which are now recognised here and in other reports for the respective health roles of dietary quality on the one hand, and with whom the food is consumed on the other, are a challenge to more gender comprehensive public health policy.

Conclusions

Eating socially may benefit survival in elderly men through the adjunct of dietary quality; it is also positively associated with men's mental health. For women, dietary quality is associated with survival advantage which is not apparently dependent on eating-with-others. The relative gender advantage in longevity that women have in this population is not adequately explained in the present study, except that they are likely to be the ones who eat with men who benefit from this social role of food. Thus, for men and women, the provision of a healthy social environment which increases social interactions should improve health outcomes.

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None of the authors has any conflicts of interest to declare.

AUTHOR'S CONTRIBUTION

YCH, HLC, MLW and MSL designed the study; YCH, HLC and YTCL performed statistical analysis; YCH, MLW, YTCL, and MSL wrote the paper; MSL had primary responsibility for the final content.

COMPETING INTERESTS

No author has any conflict of interest in regard to this paper.

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DATA SHARING STATEMENT

No additional data are available.

ETHICS

This project was approved by the Ethics Committees of the National Health Research Institute and Academia Sinica, Taiwan.

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LEGEND

Figure 1. Gender-specific pathway analysis for the associations of eating-with-others and all-cause mortality. All values are presented as β coefficients with their p values. (A) men; (B) women.

Table 1. The baseline characteristics by daily frequency for eating-with-others

Variables	Daily frequency for eating-with-others											
	Men						Women					
	Total	0	1	2	3	p value	Total	0	1	2	3	p value
N		142	57	126	630			174	79	140	546	
%		14.3	6.96	15.6	63.1			17.8	10.2	15.7	56.4	
Median of follow-up (yrs)		8.17	8.28	8.76	8.67			8.55	8.89	8.75	8.74	
Age at baseline (yrs)	72.9±0.33	74.9±0.65	71.8±0.74	72.4±0.73	72.7±0.44	0.042	73.4±0.44	75.3±0.76	72.9±0.65	72.9±0.88	73.0±0.39	0.020
Education						<0.0001						0.963
Illiterate	18.8	24.2	16.7	8.8	20.3		56.0	57.5	55.6	52.3	56.6	
Some up to primary school	46.6	52.3	43.5	48.4	45.2		32.3	32.5	32.0	33.8	31.9	
High school and above	34.7	23.5	39.9	42.8	34.5		11.7	10.0	12.4	13.8	11.5	
Marital status						<0.0001						<0.0001
Married	78.6	36.1	48.2	75.0	92.5		49.48	15.5	19.6	37.8	68.8	
Bereaved	14.3	37.8	38.8	17.5	5.43		48.12	80.6	71.1	60.7	30.3	
Others	7.15	26.1	13.0	7.55	2.11		2.40	3.87	9.32	1.56	0.95	
Live alone	13.7	60.4	0.00	9.67	1.47	<0.0001	10.3	49.4	6.43	2.91	0.42	<0.0001
Whether enough money						0.030						0.001
More than enough	78.4	71.8	79.9	85.8	77.8		75.0	64.1	63.1	78.3	79.5	
Just enough	19.2	21.7	20.2	13.0	20.1		21.0	28.7	28.8	21.0	17.2	
Not enough	2.46	6.52	0.00	1.26	2.14		4.01	7.23	8.13	0.70	3.25	
Smoker	65.7	70.5	82.0	63.9	63.2	0.078	4.92	2.44	2.55	5.34	6.01	0.171
Appetite status						0.232						0.112
Good	38.5	33.0	45.0	36.6	39.4		30.4	24.9	42.9	31.7	29.5	
Fair	55.5	62.5	41.5	59.4	54.5		59.4	57.2	48.8	61.5	61.4	
Poor	6.07	4.54	13.5	4.09	6.08		10.2	17.9	8.34	6.87	9.14	
Body mass index (kg/m^2)	23.3±0.15	22.9±0.46	23.2±0.64	23.2±0.33	23.3±0.17	0.738	23.9±0.25	23.3±0.56	25.1±0.43	24.5±0.50	23.8±0.28	0.0002
< 18.5	7.07	11.2	10.4	7.53	5.66		7.01	8.07	0.00	3.83	8.72	
18.5–23.9	52.5	54.1	53.4	50.6	52.6		44.0	51.0	39.6	40.9	43.6	

24.0–26.9	28.0	19.0	19.9	34.0	29.2		27.8	24.7	34.1	25.3	28.1	
≥ 27.0	12.5	15.7	16.3	7.91	12.6		21.3	16.3	26.3	30.0	19.6	
Physical activity (MET/day)						0.173						0.017
<1.5	51.6	45.3	44.0	51.2	54.0		61.1	60.5	51.0	52.9	65.4	
1.5–2.9	11.3	14.3	17.9	14.2	9.17		11.8	14.3	6.16	14.0	11.4	
≥3	37.1	40.4	38.1	34.7	36.8		27.1	25.2	42.8	33.1	23.2	
Shopping						0.239						0.037
<1/wk	43.8	34.2	44.5	45.9	45.5		54.9	65.3	46.6	50.9	54.3	
1/wk	12.7	13.5	15.2	13.0	12.2		13.6	10.2	14.8	18.4	13.1	
1–2/wk	23.3	24.7	21.0	19.6	24.2		19.8	14.9	24.7	22.0	19.8	
Everyday	20.2	27.6	19.3	21.6	18.3		11.7	9.63	13.9	8.74	12.9	
Current cooking activity						<0.0001						0.004
Never	58.4	33.2	44.1	58.1	65.8		26.8	24.1	12.1	31.5	29.1	
Sometimes	20.3	13.1	19.2	24.8	20.8		13.2	5.10	9.1	16.0	15.8	
Often	6.83	6.63	11.4	9.63	5.66		10.5	6.94	20.0	12.6	9.23	
Usually	14.5	47.0	25.2	7.46	7.69		49.5	63.9	58.8	39.9	45.9	
Activities of daily living	0.33±0.05	0.52±0.18	0.19±0.15	0.07±0.05	0.36±0.07	0.004	0.57±0.08	1.18±0.34	0.27±0.13	0.28±0.17	0.50±0.10	0.088
Skeletal muscle mass index (kg/ m^2)	12.3±0.12	12.0±0.27	12.2±0.29	12.0±0.20	12.5±0.13	0.149	9.28±0.12	9.14±0.22	9.52±0.20	9.32±0.17	9.29±0.15	0.213
Charlson comorbidity index	4.71±0.20	5.20±0.48	4.22±0.39	4.85±0.61	4.62±0.20	0.365	4.77±0.21	5.06±0.51	4.74±0.59	4.21±0.29	4.84±0.24	0.142
Self-perceived health status						0.400						<0.0001
Excellent	4.55	7.12	7.46	1.23	4.47		2.58	2.88	0	3.14	2.80	
Very good	19.9	16.5	13.8	29.9	18.9		15.7	10.7	24.3	14.1	16.0	
Good	21.4	25.8	19.0	17.3	21.8		16.1	11.8	9.85	17.7	18.2	
Fair	41.1	38.2	40.3	40.7	41.9		48.3	47.9	56.7	50.4	46.2	
Poor	13.1	12.4	19.5	10.9	13.1		17.4	26.7	9.25	14.7	16.8	
Cognitive impairment	8.81	12.6	1.82	3.10	10.2	0.005	27.4	30.9	25.9	30.4	25.8	0.751

All data weighted for unequal probability of sampling design by SUDAAN. Categorical variables are presented as n (%), and continuous variables are presented as mean±SE.

ANOVA and chi-square were used for continuous and categories variables to test difference between the groups by gender.

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Table 2. Food, nutrient intakes and daily frequency of eating-with-others by gender

	Daily frequency for eating-with-others									
	Men					Women				
	0	1	2	3	p value	0	1	2	3	p value
Food preparation, %										
Skipping meals	11.2	16.5	5.75	2.96	0.008	6.54	8.45	4.76	4.27	0.370
Who prepared breakfast?					<0.0001					0.003
Self	57.6	45.7	37.0	12.7		74.0	76.2	61.3	57.2	
Others	28.6	36.4	56.1	85.8		23.9	20.7	36.1	41.5	
Eating out	13.8	17.9	6.96	1.52		2.14	3.12	2.62	1.35	
Who prepared lunch?					<0.0001					0.0001
Self	59.0	40.8	11.3	9.07		68.1	74.2	48.0	53.1	
Others	31.3	34.9	85.0	89.0		26.3	18.1	50.0	45.2	
Eating out	9.72	24.3	3.66	1.90		5.59	7.73	1.96	1.63	
Who prepared dinner?					<0.0001					0.009
Self	60.0	25.0	6.20	8.52		67.7	60.1	44.6	51.4	
Others	32.9	74.0	92.1	90.7		30.2	39.9	55.4	48.1	
Eating out	7.05	1.03	1.73	0.76		2.11	0.00	0.00	0.51	
If you need to prepare meals for yourself, who gets the food?					<0.0001					0.118
Never prepare	6.21	15.8	9.38	9.32		8.37	1.67	5.24	6.60	
Self	61.2	23.4	21.2	18.6		60.2	67.4	48.2	48.4	
Others	32.6	60.8	69.5	72.1		31.4	31.0	46.6	45.0	
Dietary diversity score, mean±SE	4.27±0.11	4.13±0.17	4.57±0.11	4.61±0.06	0.003	4.28±0.13	4.32±0.14	4.69±0.10	4.46±0.06	0.009
≤3 (%)	24.1	22.1	12.2	12.1	0.010	30.2	20.7	8.05	17.5	0.001
4 (%)	30.0	41.4	30.2	32.4		24.1	31.2	31.5	31.3	
5 (%)	35.4	28.4	39.6	35.8		25.1	31.7	42.8	34.8	

6 (%)	10.8	8.13	18.0	19.7		20.7	16.4	17.6	16.4	
Food intake other than cereal (times/d), mean±SE										
Dairy	0.57±0.07	0.40±0.09	0.65±0.08	0.62±0.05	0.116	0.80±0.08	0.89±0.14	0.74±0.09	0.72±0.05	0.480
Meat	1.02±0.09	1.98±0.08	1.59±0.19	1.30±0.07	0.001	0.81±0.15	0.86±0.16	1.20±0.16	1.13±0.08	0.017
Seafood	0.86±0.18	0.93±0.12	1.08±0.12	0.99±0.08	0.524	0.70±0.10	0.92±0.12	0.91±0.09	0.99±0.07	0.026
Egg	0.44±0.08	0.39±0.05	0.46±0.05	0.46±0.03	0.687	0.23±0.03	0.36±0.04	0.36±0.03	0.38±0.03	0.003
Soy	0.48±0.09	0.43±0.06	0.47±0.06	0.45±0.04	0.824	0.39±0.06	0.50±0.10	0.61±0.07	0.51±0.05	0.063
Vegetable	1.90±0.18	1.84±0.13	2.57±0.13	2.47±0.12	0.004	2.09±0.14	2.28±0.13	2.35±0.14	2.52±0.14	0.011
Fruit	0.99±0.11	0.93±0.13	1.21±0.09	1.19±0.04	0.073	0.91±0.10	0.90±0.07	1.21±0.10	1.07±0.06	0.058
Total energy intake (kcal), mean±SE	1833±100	1849±123	1871±118	1815±77.4	0.940	1327±92.6	1518±126	1500±58.7	1521±84.3	0.206
Nutrient density (/1,000 kcal), mean±SE										
Carbohydrate (g)	132±4.79	137±5.21	139±2.58	139±2.71	0.438	155±3.55	143±5.63	144±3.31	144±1.82	0.028
Dietary fiber (g)	11.2±0.79	11.7±0.87	12.4±0.75	11.7±0.45	0.653	15.5±2.05	14.1±1.44	14.0±1.02	12.7±0.57	0.416
Fat (g)	32.1±1.42	30.5±2.15	30.2±1.28	29.5±0.82	0.377	24.7±1.13	29.7±2.30	29.2±1.50	28.9±0.85	0.002
Protein (g)	41.9±1.80	43.3±2.52	41.5±1.34	43.2±1.16	0.690	41.6±1.77	42.1±2.06	42.8±1.32	41.8±1.27	0.923
Vitamin B-1 (mg)	0.63±0.06	0.78±0.07	0.69±0.04	0.70±0.03	0.645	0.71±0.08	0.69±0.05	0.76±0.07	0.66±0.03	0.449
Vitamin B-2 (mg)	0.84±0.06	0.88±0.12	0.78±0.06	0.81±0.04	0.801	1.02±0.07	1.11±0.14	1.05±0.09	0.85±0.04	0.107
Vitamin B-6 (mg)	0.73±0.07	0.82±0.09	0.75±0.05	0.72±0.03	0.586	0.65±0.05	0.81±0.08	0.73±0.03	0.71±0.03	0.421
Vitamin C (mg)	92.5±12.2	88.4±12.8	87.5±8.69	90.6±6.18	0.984	110±9.32	103±11.5	131±20.0	105±7.72	0.597
Calcium (mg)	382±26.2	338±41.7	336±21.0	365±16.3	0.353	536±43.0	455±42.4	483±41.7	432±19.8	0.166
Magnesium (mg)	139±7.34	141±12.1	143±6.63	145±3.84	0.907	167±9.06	157±7.87	159±9.59	147±4.55	0.142

All data weighted for unequal probability of sampling design by SUDAAN.

ANOVA and chi-square were used for continuous and categories variables to test difference between the groups by gender.

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Table 3. Health-related quality of life (SF-36) according to daily frequency eating-with-others by gender

	Daily frequency eating-with-others									
	Men					Women				
	0	1	2	3	p value	0	1	2	3	p value
General health	52.8±1.18	52.0±1.49	52.9±1.10	51.5±0.50	0.538	47.1±0.99	48.6±1.23	49.7±1.24	49.0±0.84	0.211
Mental health	51.4±0.91	49.3±1.88	52.3±1.13	52.5±0.50	0.222	47.8±1.30	47.3±1.45	48.8±1.27	49.2±1.02	0.542
Physical functioning	51.1±1.16	50.4±1.26	53.3±0.68	51.5±0.65	0.044	45.2±0.96	50.7±0.97	48.2±1.03	47.0±0.64	0.002
Body pain	51.2±1.20	51.5±1.63	52.8±1.04	51.9±0.68	0.529	46.5±1.08	47.4±1.20	49.5±1.00	48.0±0.69	0.112
Role limitations due to emotional problems	50.0±1.19	47.7±1.69	51.5±0.93	51.2±0.63	0.160	47.5±1.16	50.8±1.51	49.6±1.13	49.3±0.86	0.354
Role limitations due to physical problems	50.2±1.36	49.5±1.31	52.1±1.01	51.4±0.67	0.254	46.1±1.03	51.4±1.28	48.7±1.55	49.7±0.87	0.005
Social function	50.0±1.22	49.4±1.71	51.9±0.99	50.9±0.67	0.262	48.2±1.17	48.6±1.31	50.0±1.31	49.0±0.71	0.698
Vitality	51.0±1.32	49.4±1.76	51.7±1.02	51.8±0.68	0.591	47.1±0.95	49.2±1.72	48.1±1.45	48.1±0.75	0.553

All data weighted for unequal probability of sampling design by SUDAAN.
ANOVA was used for continuous and categories variables to test difference between the groups by gender.

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Table 4. Gender-specific hazard ratios (95% CI) of association between eating-with-others and risk of mortality in older adults

	Daily frequency of eating-with-others							
	Men				Women			
	0	1	2	3	0	1	2	3
Deceased/survival, n	75/67	26/31	37/89	248/382	60/114	20/59	36/104	196/350
Crude model	1.00	0.90 (0.60–1.35)	0.42*** (0.28–0.61)	0.67** (0.52–0.88)	1.00	0.53 (0.27–1.05)	0.68 (0.42–1.11)	0.86 (0.64–1.16)
Model 1	1.00	1.12 (0.71–1.78)	0.48** (0.31–0.74)	0.76 (0.57–1.03)	1.00	0.54 (0.24–1.23)	0.89 (0.53–1.49)	1.07 (0.77–1.49)
Model 2†	1.00	0.76 (0.37–1.56)	0.43** (0.25–0.73)	0.63* (0.41–0.98)	1.00	0.56 (0.29–1.07)	0.68 (0.35–1.30)	0.69 (0.39–1.21)
Model 3†	1.00	0.78 (0.39–1.55)	0.46** (0.28–0.77)	0.66 (0.43–1.02)	1.00	0.54 (0.27–1.06)	0.70 (0.36–1.36)	0.72 (0.40–1.27)

Data were weighted for unequal probability of sampling design by SUDAAN and estimated HR (95% CI) by using the Cox proportional-hazard model.

Model 1: adjusted for age

Model 2: adjusted for age, education (illiterate, primary school, high school and above), region (Hakka, mountains, Eastern Taiwan, Penghu, Northern Taiwan 1–3, Central Taiwan 1–3, Southern Taiwan 1–3), live alone (live alone, live with others), cook frequency (never, sometimes, often, frequently), marital status (married, bereaved, other), appetite status (good, fair, poor), dietary diversity score (≤3, 4, 5, 6), activities of daily living and body mass index (<18.5, 18.5–23.9, 24.0–26.9, ≥27 kg/m^2)

Model 3: model 2 plus adjusted self-rate financial status (more than enough, just enough, not enough)

†Women were not adjusted for activities of daily living in the models since it is highly correlated with cooking frequency.

*p<0.05; **p<0.01; ***p<0.001

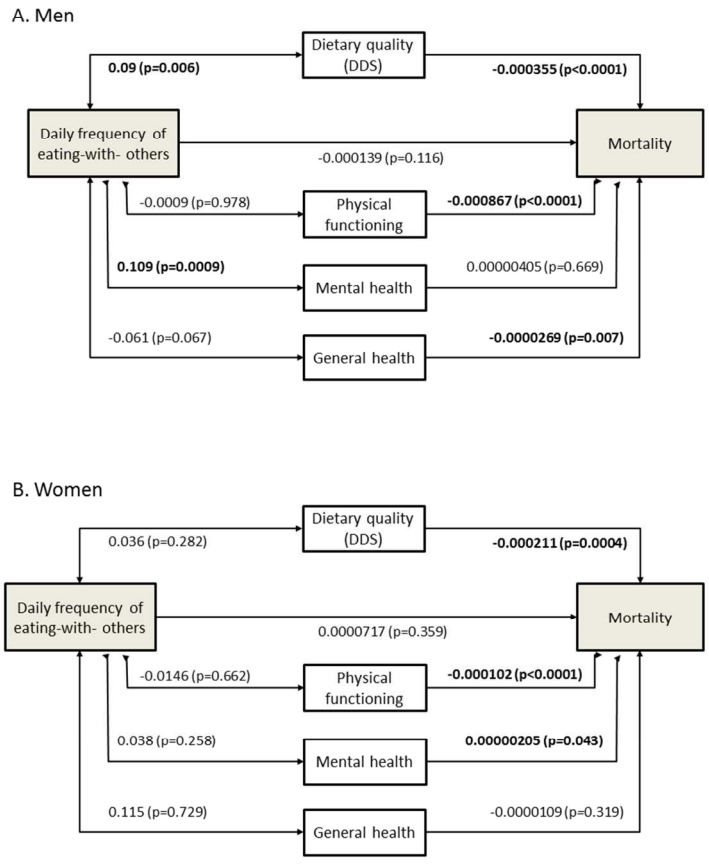

Figure 1. Gender-specific pathway analysis for the associations of eating-with-others and all-cause mortality. All values are presented as β coefficients with their p values. (A) men; (B) women.

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Supplementary table 1. Spearman rank correlation coefficients between daily frequency of eating with others and co-variables

	Spearman rank correlation coefficients	
	Men	Women
Education – higher	0.067*	0.037
Marital status – married	0.522***	0.460***
Dietary diversity score – higher	0.092**	0.033
Body mass index – higher	0.037	0.025
Age – older	-0.092**	-0.127**
Live alone	-0.648***	-0.592***
Cooking frequency – more	-0.407***	-0.157***
Appetite status – poor	-0.035	-0.01
Activities of daily living – more difficulties	-0.037	-0.087**
Self-rate financial status – not enough	-0.066*	-0.124**

*p<0.05; **p<0.001; ***p<0.0001

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation	Page
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4-5
Methods			
Study design	4	Present key elements of study design early in the paper	5-7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5-7
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	5, 7
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5-7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5-7
Bias	9	Describe any efforts to address potential sources of bias	13
Study size	10	Explain how the study size was arrived at	N/A
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	5, 6-7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7-8
		(*b*) Describe any methods used to examine subgroups and interactions	7
		(*c*) Explain how missing data were addressed	5
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	5
		(*e*) Describe any sensitivity analyses	13

Continued on next page

Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5
		(b) Give reasons for non-participation at each stage	5
		(c) Consider use of a flow diagram	N/A
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8-9 (Table 1)
		(b) Indicate number of participants with missing data for each variable of interest	5
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	Table 1
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	Table 4
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9 (Table 4)
		(*b*) Report category boundaries when continuous variables were categorized	7
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	N/A
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	7
Discussion			
Key results	18	Summarise key results with reference to study objectives	10
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14
Generalisability	21	Discuss the generalisability (external validity) of the study results	14
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	15

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.