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

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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.

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4 **Key words:** elderly, diet, mortality, social activities
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8 **STRENGTHS AND LIMITATIONS OF THIS STUDY**
9

- 10 ● Use of a representative free-living Taiwanese cohort with 10 years' follow-up for
11 survival.
12
13 ● Study design provided an understanding of eating arrangements for older adults in a
14 community setting.
15
16 ● A comprehensive assessment of the gender-specific associations between
17 eating-with-others and mortality for older adults.
18
19 ● The frequency, but not duration of time spent eating alone or eating-with-others was
20 considered.
21
22 ● Participants were mainly of Chinese ethnicity from Taiwan so that the generalisability of
23 findings may be limited.
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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

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4 frequency questionnaire.¹⁶ Dietary quality and nutritional intake were measured through
5
6 one-day 24-hour dietary recall. The dietary quality was evaluated using the dietary diversity
7
8 score (DDS), which is based on the consumption of a half serving of the following six food
9
10 groups daily: grains; meat, fish, or eggs; dairy; vegetables; fruits; and oil or fat. The DDS
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12 score ranges from 0 to 6, with a higher score representing higher dietary quality. The method
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14 of nutrient intake calculation is described elsewhere.⁷
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20 **Other variables**

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22 Participants were also asked how frequently they cooked or aided with cooking (excluding
23
24 ready-to-eat meals), and their responses were recorded as never, sometimes, often, or usually.
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26 Participants were then asked how many people they lived with. The response “0” was defined
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28 as living alone.
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31 Health-related quality of life was measured by a 36 item Short Form (SF-36) in a
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33 validated traditional Chinese version. A total of 8 dimensions of health, included physical
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35 functioning, role limitations due to physical problems, mental health, role limitations due to
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37 emotional problems, social function, bodily pain, vitality and general health. The score was
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39 calculated by the norm-based scoring system ($\mu=50$, $\sigma=10$) and standardised. Higher scores
40
41 indicated a better quality of life.¹⁷
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44 Disability was evaluated by activities of daily living (ADL) which included 9 questions
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46 about self-care task difficulty in an older adult’s daily life.
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50 **Outcome ascertainment**

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

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10 All data analyses were stratified by gender. Categorical variables and continuous variables
11 were presented as n (%) or mean \pm standard errors (SE). Chi-square and ANOVA were used to
12 determine the association between eating arrangements and baseline characteristics for
13 categorical or continuous variables, respectively. The Cox proportional-hazards regression
14 model was used to evaluate the association between daily frequency eating-with-others and
15 risk of all-cause mortality. Additional factors were age, education level (illiterate, primary
16 school, high school and above), marital status (married, bereaved, other), region (Hakka,
17 mountains, Eastern Taiwan, Penghu, Northern Taiwan 1–3, Central Taiwan 1–3, Southern
18 Taiwan 1–3), living arrangement (live alone, live with others), BMI (<18.5, 18.5–23.9,
19 24.0–26.9, ≥ 27), DDS (≤ 3 , 4, 5, 6), cooking frequency (never, sometimes, often, frequently),
20 appetite status (good, fair, poor), ADL and self-rate financial statue (more than enough, just
21 enough, not enough). All data analyses were performed using SAS 9.2 and SUDAAN 9.0 to
22 adjust for the design effect of sampling.
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39 To explore the pathways which might connect eating-with-others to survival, we have
40 considered the intermediates of dietary quality (DDS), physical functioning, mental health,
41 and general health. The first linkage, using continuous variables, has been assessed by
42 Pearson's partial correlation coefficients. The second linkage to risk of mortality, as
43 coefficients, has been assessed by the Aalen additive hazards model.¹⁸
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53 **RESULTS**

54
55 In total, 63.1% of men and 56.4% of women ate with others 3 times a day. The mean age of
56 men and women who ate alone was significantly higher than those who ate with others 3 times
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4 (74.9 vs. 72.7 years and 75.3 vs. 73.0 years). For both genders, those who ate with others were
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6 more likely to be married, better financial status, living with others, and less cooking than
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8 were those who ate alone. Men who ate alone had significantly higher ADLs than those who
9
10 ate with others ($p=0.004$). (Table 1)

11
12 Table 2 presents the dietary quality and food intakes for daily frequency of
13
14 eating-with-others by gender. A total of 24.1% of men and 30.2% of women who ate alone
15
16 had a poor dietary quality ($DDS \leq 3$), compared to those who ate with others 3 times daily
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18 (12.1%, 17.5% respectively). Men who ate alone ate less meat (1.02 vs. 1.30 times/d) and
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20 vegetables (1.90 vs. 2.47 times/d) than did those who ate with others 3 times a day ($p<0.05$).
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22 Women who ate with others 3 times a day tended to eat more meat (1.13 vs 0.81 times/d),
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24 seafood (0.99 vs. 0.70 times/d), eggs (0.38 vs. 0.23 times/d), and vegetable (2.52 vs. 2.09
25
26 times/d) intake than did those who ate alone ($p<0.05$). Further, women who ate alone had
27
28 lower fat (24.7 vs. 28.9 g/1000 kcal/d) intakes, but higher carbohydrate (155 vs. 144 g/1000
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30 kcal/d) intakes compared with those who ate with others ($p<0.05$).
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35 Regarding meals, 57.6%, 59.0%, and 60.0% of men and 74.0%, 68.1%, and 67.7% of
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37 women prepared breakfast, lunch, and dinner respectively when eating alone. Men were more
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39 likely to eat out (highest of 24.3% for lunch) when eating-with-others once a day compared
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41 with women (highest of 7.73% for lunch). Furthermore, men who prepared meals for
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43 themselves when eating alone were more likely to have purchased the food (61.2%) than were
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45 those who ate with others.
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49 Men who ate with others twice per day have significantly high physical functioning
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51 compared with other groups ($p=0.044$). For women, who ate with others once per day have
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53 higher physical functioning (50.7 vs. 45.2) and role limitations due to physical problem (51.4
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55 vs. 46.1) compared with those who ate alone. (Table 3)

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57 Table 4 presents the association between daily frequency eating-with-others and risk of
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4 all-cause mortality by gender. In the crude model, the HRs (95% CI) of risk of all-cause
5 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)
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8 in men and 0.68 (0.42–1.11), 0.86 (0.64–1.16) in women compared with those who ate alone,
9
10 respectively. When adjusted for age, education, marital status, region, living arrangement,
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12 cooking, appetite status, ADL, DDS, BMI, the HRs (95% CI) were 0.43 (0.25–0.73), 0.63
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14 (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
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16 or 3 times a day. With further adjustment for financial status, the risk of mortality is reduced
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18 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
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20 ate with others 2 or 3 times a day.
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24 The pathway analyses are shown in Figure 1. For men, there are significant positive
25
26 associations between eating-with-others frequency and dietary quality (DDS) ($p=0.006$) as
27
28 well as mental health ($p=0.0009$). In turn, better dietary quality ($p<0.0001$) is associated with
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30 less mortality risk, as are physical functioning ($p<0.0001$) and general health ($p=0.007$). For
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32 women, eating-with-others is not associated with any of dietary quality, physical functioning,
33
34 mental health or general health; however, dietary quality ($p=0.0004$) and physical functioning
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36 ($p<0.0001$) are inversely associated with mortality risk, while mental health ($p=0.043$) is
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38 positively associated.
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44 **DISCUSSION**

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

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4 Eating-with-others has numerous beneficial effects on health. A randomized controlled trial at
5
6 a Dutch nursing home found that family-style meals that included the presence of others
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8 increased the energy intake and reduced the prevalence of malnutrition. Those who ate with
9
10 others ate more than those who ate alone. Social eating may stimulate intake through extension
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12 of meal duration and improved ambiance.¹⁹ The presence of others in the household did not
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14 affect energy intake, but the presence of others during mealtime did, with an average of 114
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16 calories more per meal than those who ate alone.²⁰ Eating socially also improved dietary
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18 quality and diversity.²¹ However, the present study shows that after control for dietary quality in
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20 the model, eating-with-others and mortality remains associated. A possible reason for this is
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22 that solitary eating is often associated with depression,⁴⁻⁶ in turn associated with mortality.
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28 **Eating-with-others and mortality**

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30 Our findings are consistent with several studies from Western countries. The Nutrition
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32 Screening Initiative (NSI) checklist, a tool for malnutrition screening and awareness in older
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34 adults in the US, asks questions regarding solitary eating. In a cohort study with 581
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36 community-dwelling older adults, who ate more than 17 meals alone per week, exhibited a
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38 2.07-fold higher risk of mortality (RR=2.07, 95% CI=1.49–2.86) over an 8–12-year period.¹⁰
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40 Another study in Botswana found that older adults who ate alone had a higher risk of death
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42 (OR=6.7, 95% CI=2.2–20.0).⁹ However, these studies did not factor in gender.
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48 **Eating alone and gender**

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50 In the present study, men who ate with others had a lower risk of mortality than did those who
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52 ate alone, for several probable reasons. Men who ate with others had better dietary quality and a
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54 higher vegetable intake than those eating alone. We also found that men who ate alone were
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56 more likely to eat out, not prepare meals by themselves, and frequently skip meals than did
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4 women. A Japanese cohort study discovered that men who ate alone were more likely to be
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6 underweight and skip meals and less likely to eat fruits and vegetables.²¹ Underweight older
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8 adults with poor dietary quality and low fruit and vegetable intakes have been associated with a
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10 higher risk of mortality.^{7 22} Furthermore, in our study, eating out is often associated with
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12 high-fat foods with poor quality. Men who were solitary eaters had low carbohydrate, protein,
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14 dietary fiber, and other nutrient intakes, but a higher fat intake than those who ate with others,
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16 although the differences were non-significant.
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19 Compared with Japan,²¹ in our study men have a higher rate of solitary eating, but women
20
21 have a lower rate. Taiwanese men who eat alone are more likely to be unmarried or live
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23 separately from their spouse. We found that the eating companionship of men who ate with
24
25 others was usually their spouse or children rather than friends or neighbours (data not shown).
26
27 Davis et al. found that dietary patterns of older men had stronger associations with living
28
29 arrangements than did those of older women.²³ Cooking itself is a physical activity and a
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31 cognitive function, and in Taiwanese culture women are more likely to prepare meals. Men eat
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33 out or buy ready-to-eat food more than they cook. In this study, men (47.0%) cooked less than
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35 did women (63.9%) when eating alone (Table 1). Men who ate alone shopped more than did
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37 women who ate alone (27.6% vs. 9.6%).
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44 **Pathways from eating-with-others to survival**

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46 For men but not women, pathway analyses indicate that dietary quality, assessed as dietary
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48 diversity, provides a potential connection between the social aspect of eating-with-others and
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50 survival (Figure 1). This underscores the likely basic importance of nutritional factors in
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52 life-long health, but draws attention to the social as well as the biomedical role of food in
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54 health. For men, on pathway analysis, eating-with-others is associated with better mental
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56 health. Since pathway analysis requires that all independent variables are continuous, this may
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4 have resulted in an absence of a significant direct association of eating-with-others with
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6 mortality due to its frequency not being linearly related to mortality; this contrasts with the
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8 survival analyses by Cox regression (Table 4). In addition, by pathway analysis, each of
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10 physical functioning and general health are themselves important in the prediction of
11
12 mortality risk in men. It remains conceivable that the dietary quality that men achieve,
13
14 irrespective of eating-with-others, plays a role in each of physical functioning and general
15
16 health, which is evident in this population.^{7 17}

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19 In the case of women, dietary quality directly and favourably predicts survival, but this
20
21 connection is not found to be dependent on eating-with-others. Perhaps women can achieve
22
23 the biomedical benefit of survival through diet without the need for its social function. In
24
25 addition, women have a more favourable survival with better physical functioning.
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27 Somewhat surprisingly, better mental health is unfavourably associated with survival,
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29 although this is weakly significant. It is possible that confounders that have not been
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31 considered in this pathway analysis might account for this mental health association with
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33 mortality in older women. For example, in devoting themselves to the care of others, or in
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35 dealing successfully with a relative socio-economic disadvantage in widowhood, a sense of
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37 wellbeing may obtain, while health adversity supervenes.
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44 **Limitations**

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46 There are some limitations to this study. First, the association may be affected by the duration of
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48 time spent eating alone or eating-with-others, which was not considered. Second, in Taiwanese
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50 society, older people are more likely to live with and depend on their families, so the culturally
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52 specific nature of this study may limit its applicability elsewhere. The study should be
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54 considered within a Taiwanese (of perhaps a broader Asian) context. As with cohort studies in
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56 general, there may have been confounders not considered which might have explained the
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4 associations presented. The study itself, however, has sought to consider the circumstances of
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6 eating which are usually neglected in the exploration of food and nutrient health relationships.
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8 The pathway analyses are an attempt to encompass more of the explanatory models for these
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10 relationships by way of inclusion of physical, mental and general health. The gender
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12 differences which are now recognised here and in other reports for the respective health roles of
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14 dietary quality on the one hand, and with whom the food is consumed on the other, are a
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16 challenge to more gender comprehensive public health policy.
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22 **Conclusions**

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24 Eating socially may benefit survival in elderly men through the adjunct of dietary quality; it is
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26 also positively associated with men's mental health. For women, dietary quality is associated
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28 with survival advantage which is not apparently dependent on eating-with-others. The relative
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30 gender advantage in longevity that women have in this population is not adequately explained
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32 in the present study, except that they are likely to be the ones who eat with men who benefit
33
34 from this social role of food. Thus, for men and women, the provision of a healthy social
35
36 environment which increases social interactions should improve health outcomes.
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45
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47
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51

52
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54
55 Health Research Institutes. The interpretation and conclusions contained herein do not
56
57 represent those of Department of Health, or National Health Research Institutes.
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4 None of the authors has any conflicts of interest to declare.
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8 9 **AUTHOR'S CONTRIBUTION**

10 YCH, HLC, MLW and MSL designed the study; YCH, HLC and YTCL performed statistical
11 analysis; YCH, MLW, YTCL, and MSL wrote the paper; MSL had primary responsibility for
12 the final content.
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17 18 19 20 **COMPETING INTERESTS**

21 No author has any conflict of interest in regard to this paper.
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29 MOST-103-2320-B-016-015-MY2.
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36 **DATA SHARING STATEMENT**

37 No additional data are available.
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43 **ETHICS**

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

1. Rowe JW, Kahn RL. Successful aging. *Gerontologist* 1997;37:433–40.
2. Meiselman HL. Dimensions of the meal. *Journal of Foodservice* 2008;19:13–21. doi: 10.1111/j.1745-4506.2008.00076.x.
3. Administration for Community Living., US Department of Health and Human Services. Nutrition Services (OAA Title IIIC) - Congregate Nutrition Services Washington, DC: Administration for Community Living, US Department of Health and Human Services; 2016 [cited 2016 18th April]. Available from: http://www.aoa.gov/AoA_programs/HPW/Nutrition_Services/index.aspx#congregate accessed 18th April 2016.
4. Kuroda A, Tanaka T, Hirano H, *et al.* Eating alone as social disengagement is strongly associated with depressive symptoms in Japanese community-dwelling older adults. *J Am Med Dir Assoc* 2015;16:578–85. doi: 10.1016/j.jamda.2015.01.078.
5. Tani Y, Sasaki Y, Haseda M, *et al.* Eating alone and depression in older men and women by cohabitation status: The JAGES longitudinal survey. *Age Ageing* 2015;44:1019–26. doi: 10.1093/ageing/afv145.
6. Wang X, Shen W, Wang C, *et al.* Association between eating alone and depressive symptom in elders: a cross-sectional study. *BMC Geriatr* 2016;16:19. doi: 10.1186/s12877-016-0197-2.
7. Lee MS, Huang YC, Su HH, *et al.* A simple food quality index predicts mortality in elderly Taiwanese. *J Nutr Health Aging* 2011;15:815–21.
8. Schoevers RA, Geerlings MI, Beekman AT, *et al.* Association of depression and gender with mortality in old age. Results from the Amsterdam Study of the Elderly (AMSTEL). *Br J Psychiatry* 2000;177:336–42.
9. Clausen T, Wilson AO, Molebatsi RM, *et al.* Diminished mental- and physical function and

- 1
2
3 lack of social support are associated with shorter survival in community dwelling older
4
5 persons of Botswana. *BMC Public Health* 2007;7:144. doi: 10.1186/1471-2458-7-144.
6
7
8 10. Sahyoun NR, Jacques PF, Dallal GE, *et al.* Nutrition Screening Initiative Checklist may
9
10 be a better awareness/educational tool than a screening one. *J Am Diet Assoc*
11
12 1997;97:760–4. doi: 10.1016/s0002-8223(97)00188-0.
13
14 11. Ek S. Gender differences in health information behaviour: a Finnish population-based
15
16 survey. *Health Promot Int* 2015;30:736–45. doi: 10.1093/heapro/dat063.
17
18
19 12. Redondo-Sendino A, Guallar-Castillon P, Banegas JR, *et al.* Gender differences in the
20
21 utilization of health-care services among the older adult population of Spain. *BMC*
22
23 *Public Health* 2006;6:155. doi: 10.1186/1471-2458-6-155.
24
25 13. Umberson D, Wortman CB, Kessler RC. Widowhood and depression: explaining
26
27 long-term gender differences in vulnerability. *J Health Soc Behav* 1992;33:10–24.
28
29
30 14. Wu SJ, Chang YH, Wei IL, *et al.* Intake levels and major food sources of energy and
31
32 nutrients in the Taiwanese elderly. *Asia Pac J Clin Nutr* 2005;14:211–20.
33
34 15. Cheng SL. Eating-with-others and the health of older people. School of Public Health.
35
36 National Defense Medical Center, 2014.
37
38
39 16. Huang YC, Lee MS, Pan WH, *et al.* Validation of a simplified food frequency
40
41 questionnaire as used in the Nutrition and Health Survey in Taiwan (NAHSIT) for the
42
43 elderly. *Asia Pac J Clin Nutr* 2011;20:134–40.
44
45 17. Lee MS, Chen RCY, Chang YH, *et al.* Physical function mitigates the adverse effects of
46
47 being thin on mortality in a freeliving older Taiwanese cohort. *J Nutr Health Aging*
48
49 2012;16:766–83.
50
51
52 18. Gamborg M, Jensen GB, Sorensen TI, *et al.* Dynamic path analysis in life-course
53
54 epidemiology. *Am J Epidemiol* 2011;173:1131–9. doi: 10.1093/aje/kwq502.
55
56
57 19. Nijs KA, de Graaf C, Siebelink E, *et al.* Effect of family-style meals on energy intake and
58
59
60

- 1
2
3 risk of malnutrition in dutch nursing home residents: a randomized controlled trial. *J*
4
5 *Gerontol A Biol Sci Med Sci* 2006;61:935–42.
6
7
8 20. Locher JL, Robinson CO, Roth DL, *et al*. The effect of the presence of others on caloric
9
10 intake in homebound older adults. *J Gerontol A Biol Sci Med Sci* 2005;60:1475–8.
11
12 21. Tani Y, Kondo N, Takagi D, *et al*. Combined effects of eating alone and living alone on
13
14 unhealthy dietary behaviors, obesity and underweight in older Japanese adults: Results
15
16 of the JAGES. *Appetite* 2015;95:1–8. doi: 10.1016/j.appet.2015.06.005.
17
18 22. Trichopoulou A, Kouris-Blazos A, Wahlqvist ML, *et al*. Diet and overall survival in
19
20 elderly people. *BMJ* 1995;311:1457–60.
21
22 23. Davis MA, Randall E, Forthofer RN, *et al*. Living arrangements and dietary patterns of
23
24 older adults in the United States. *J Gerontol* 1985;40:434–42.
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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.

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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	

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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	

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	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.

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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.

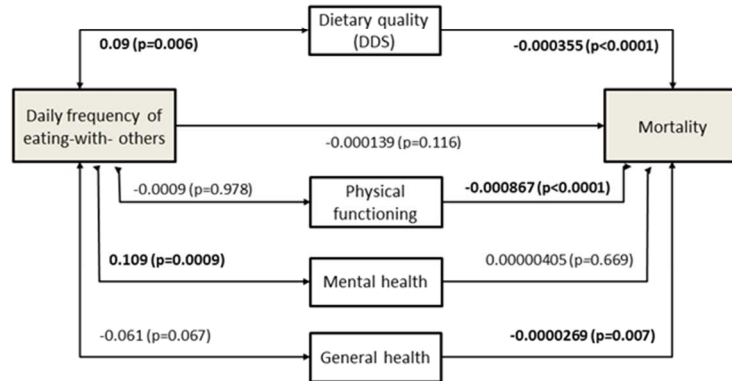
Model 1: adjusted for age

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

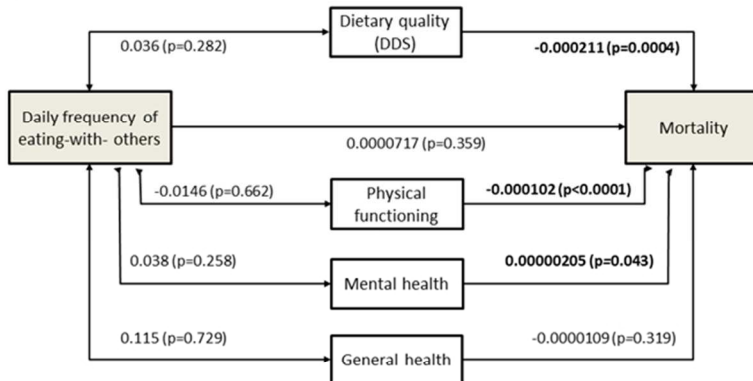
Model 3: model 5 plus adjusted self-rate financial status

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

A. Men



B. Women



190x275mm (96 x 96 DPI)

BMJ Open

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

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4 1 **TITLE PAGE**5
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7 2 **Gender differences in longevity in free-living older adults who**
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9 3 **eat-with-others: a prospective study in Taiwan**10
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51 27 and tables)

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3
4 28 **ABSTRACT**

5
6 29 **Objectives:** Social activities such as 'eating-with-others' can positively affect the ageing
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9 30 process. We investigated the gender-specific association between eating arrangements and risk
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11 31 of all-cause mortality among free-living older adults.

12
13 32 **Setting:** A representative sample from the elderly Nutrition and Health Survey in Taiwan
14
15 33 during 1999-2000.

16
17 34 **Participants:** Some 1,894 participants (955 men and 939 women) who aged ≥ 65 and
18
19 35 completed eating arrangement question as well as confirmed survivorship information.

20
21 36 **Primary and secondary outcome measures:** Eating arrangements, health condition, and
22
23 37 24-hour dietary recall information were collected at baseline. We classified eating
24
25 38 arrangements as the daily frequency of eating-with-others (0–3). Survivorship was determined
26
27 39 by the National Death Registry until the end of 2008. Cox proportional-hazards regression was
28
29 40 used to assess the association between eating-with-others and mortality risk.

30
31 41 **Results:** Overall, 63.1% of men and 56.4% of women ate with others 3 times a day. Both men
32
33 42 and women who ate with others were more likely to have higher meat and vegetable intakes,
34
35 43 and greater dietary quality than those who ate alone. The hazard ratios (HRs) (95% CI) for
36
37 44 all-cause mortality when eating-with-others 2 and 3 times daily were 0.46 (0.28–0.61), 0.67
38
39 45 (0.52–0.88) in men and 0.68 (0.42–1.11), 0.86 (0.64–1.16) in women, compared with those
40
41 46 who ate alone. Multivariable HRs (95% CI) were 0.43 (0.25–0.73), 0.63 (0.41–0.98) in men
42
43 47 and 0.68 (0.35–1.30), 0.69 (0.39–1.21) in women. With further adjustment for financial status,
44
45 48 HR was reduced by 54% in men who ate with others twice a day. Pathway analysis shows this
46
47 49 to be dependent on improved dietary quality by eating-with-others.

48
49 50 **Conclusions:** Eating-with-others is an independent survival factor in older men. To providing
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51 51 a social environment which encourages eating-with-others may benefit survival of older
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53 52 people, especially for men.
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4 53 **Key words:** elderly, diet, mortality, social activities
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8 55 **STRENGTHS AND LIMITATIONS OF THIS STUDY**
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- 10 56 ● Use of a representative free-living Taiwanese cohort with 10 years' follow-up for
11 survival.
12 57
13 58 ● Study design provided an understanding of eating arrangements for older adults in a
14 community setting.
15 59
16 60 ● A comprehensive assessment of the gender-specific associations between
17 eating-with-others and mortality for older adults.
18 61
19 62 ● The frequency, but not duration of time spent eating alone or eating-with-others was
20 considered.
21 63
22 64 ● Participants were mainly of Chinese ethnicity from Taiwan so that the generalisability of
23 findings may be limited.
24 65
25 66

67 INTRODUCTION

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

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

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

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

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4 92 Taiwanese cohort of older men and women.
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94 **SUBJECTS AND METHODS**

95 **Participants**

96 Participants aged 65 and over were recruited from the Elderly Nutrition and Health Survey in
97 Taiwan during 1999–2000. The details of the survey design and sampling method have been
98 published elsewhere.¹⁷ In total, 1,937 older people completed face-to-face interviews with
99 trained interviewers. We excluded 40 participants with incorrect identification or incorrect
100 identity numbers and those who did not provide relevant or required information. After which
101 1,894 participants (955 men and 939 women) remained in the study. Trained interviewers
102 collected data on sociodemographics, dietary habits and intake, and disease history. All
103 participants signed informed consent forms prior to being interviewed. This project was
104 approved by the Ethics Committees of the National Health Research Institute and Academia
105 Sinica, Taiwan.

107 **Eating arrangement**

108 Eating arrangements were assessed by asking participants whether they usually ate breakfast,
109 lunch, and dinner with others. Their responses were recorded as one of the following four
110 options: eat alone, eat with spouse, eat with children or relative(s), and eat with friend(s) or
111 neighbor(s). We then classified the eating arrangements as eating-with-others 0 (eat alone), 1,
112 2, 3 times a day.¹⁸ Information was also obtained about the person responsible for meal
113 preparation.

115 **Dietary assessment**

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

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4 117 frequency questionnaire.¹⁹ Dietary quality and nutritional intake were measured through
5
6 118 one-day 24-hour dietary recall. The dietary quality was evaluated using the dietary diversity
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8 119 score (DDS), which is based on the consumption of a half serving of the following six food
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10 120 groups daily: grains; meat, fish, or eggs; dairy; vegetables; fruits; and oil or fat. The DDS
11
12 121 score ranges from 0 to 6, with a higher score representing higher dietary quality. The method
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14 122 of nutrient intake calculation is described elsewhere.¹⁰
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20 124 **Other variables**

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22 125 Participants were also asked how frequently they cooked or aided with cooking (excluding
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24 126 ready-to-eat meals), and their responses were recorded as never, sometimes, often, or usually.
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26 127 Participants were then asked how many people they lived with. The response “0” was defined
27
28 128 as living alone.

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31 129 Health-related quality of life was measured by a 36 item Short Form (SF-36) in a
32
33 130 validated traditional Chinese version. A total of 8 dimensions of health, included physical
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35 131 functioning, role limitations due to physical problems, mental health, role limitations due to
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37 132 emotional problems, social function, bodily pain, vitality and general health. The score was
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39 133 calculated by the norm-based scoring system ($\mu=50$, $\sigma=10$) and standardised. Higher scores
40
41 134 indicated a better quality of life.²⁰

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44 135 Disability was evaluated by activities of daily living (ADL) which included 9 questions
45
46 136 about self-care task difficulty in an older adult’s daily life. We used bioelectrical impedance
47
48 137 analysis to measure muscle mass. The skeletal muscle mass index was used to determine
49
50 138 sarcopenia status, calculated with the following equation:²¹

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52
53 139 $[0.401 \times (\text{height}^2 / \text{resistance}) + (3.825 \times \text{gender}) - (0.071 \times \text{age}) + 5.102] / \text{height}^2$

54
55 140 where height is measured in metres, resistance in Ohms, and age in years; men = 1 and
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57 141 women = 0.

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4 142 The Charlson comorbidity index was used to assess multi-morbidity.²² Cognitive function
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6 143 was assessed by a validated Short Portable Mental Status Questionnaire (SPMSQ) in Chinese
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8 144 which included 10 questions about orientation in time and place, personal history, long-term
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10 145 and short-term memory and calculation. More than or equal to three erroneous responses was
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12 146 regarded as cognitive impairment.²³
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18 **Outcome ascertainment**

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20 149 National Death Registry data were obtained from Taiwan's Ministry of Health and Welfare.
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22 150 We linked the NAHSIT dataset to the National Death Registry dataset using the participant ID
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24 151 to determine survival rates. Follow-up time was calculated from date of interview to date of
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26 152 death or until December 31, 2008.
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30 **Statistical analysis**

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33 155 Categorical variables and continuous variables were presented as n (%) or mean \pm standard
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35 156 errors (SE). Chi-square and ANOVA were used to determine the association between eating
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37 157 arrangements and baseline characteristics for categorical or continuous variables, respectively.
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39 158 The Cox proportional-hazards regression model was used to evaluate the association between
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41 159 daily frequency eating-with-others and risk of all-cause mortality. Since the interaction
42
43 160 between eating arrangements and gender was significant ($p=0.0093$), we used gender-specific
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45 161 analyses. Additional factors were age, education level (illiterate, primary school, high school
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47 162 and above), marital status (married, bereaved, other), region (Hakka, mountains, Eastern
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49 163 Taiwan, Penghu, Northern Taiwan 1–3, Central Taiwan 1–3, Southern Taiwan 1–3), living
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51 164 arrangement (live alone, live with others), BMI (<18.5 , $18.5-23.9$, $24.0-26.9$, ≥ 27), DDS (≤ 3 ,
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53 165 4, 5, 6), cooking frequency (never, sometimes, often, frequently), appetite status (good, fair,
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55 166 poor), ADL and self-rate financial statue (more than enough, just enough, not enough). All
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4 167 data analyses were performed using SAS 9.2 and SUDAAN 9.0 to adjust for the design effect of
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6 168 sampling.
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9 169 To explore the pathways which might connect eating-with-others to survival, we have
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11 170 considered the intermediates of dietary quality (DDS), physical functioning, mental health,
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13 171 and general health. The first linkage, using continuous variables, has been assessed by
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15 172 Pearson's partial correlation coefficients. The second linkage to risk of mortality, as
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17 173 coefficients, has been assessed by the Aalen additive hazards model.²⁴
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21 175 **RESULTS**

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23
24 176 In total, 63.1% of men and 56.4% of women ate with others 3 times a day. For both genders,
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26 177 those who ate with others were more likely to be younger, married, better financial status,
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28 178 living with others, and less cooking than were those who ate alone. Men who ate alone had
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30 179 significantly higher ADLs ($p=0.004$) and cognitive impairment ($p=0.005$) than those who ate
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32 180 with others. (Table 1)
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34
35 181 Table 2 presents the dietary quality and food intakes for daily frequency of
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37 182 eating-with-others by gender. Those who ate alone had a poor dietary quality ($DDS \leq 3$),
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39 183 compared to those who ate with others 3 times daily. Men who ate alone ate less meat (1.02 vs.
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41 184 1.30 times/d) and vegetables (1.90 vs. 2.47 times/d) than did those who ate with others 3
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43 185 times a day ($p<0.05$). Women who ate with others 3 times a day tended to eat more meat (1.13
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45 186 vs 0.81 times/d), seafood (0.99 vs. 0.70 times/d), eggs (0.38 vs. 0.23 times/d), and vegetable
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47 187 (2.52 vs. 2.09 times/d) intake than did those who ate alone ($p<0.05$). Further, women who ate
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49 188 alone had lower fat (24.7 vs. 28.9 g/1000 kcal/d) intakes, but higher carbohydrate (155 vs. 144
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51 189 g/1000 kcal/d) intakes compared with those who ate with others ($p<0.05$). Regarding meals,
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53 190 around 58% to 60% of men and 68% to 74% of women prepared meals by themselves when
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55 191 eating alone. Men were more likely to eat out when eating-with-others once a day compared
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4 192 with women.

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6 193 Men who ate with others twice per day have significantly high physical functioning
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8 194 compared with other groups ($p=0.044$). For women, who ate with others once per day have
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10 195 higher physical functioning (50.7 vs. 45.2) and role limitations due to physical problem (51.4
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12 196 vs. 46.1) compared with those who ate alone. (Table 3)

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14
15 197 Table 4 presents the association between daily frequency eating-with-others and risk of
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17 198 all-cause mortality by gender. In the crude model, the HRs (95% CI) of risk of all-cause
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19 199 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)
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21 200 in men and 0.68 (0.42–1.11), 0.86 (0.64–1.16) in women compared with those who ate alone,
22
23 201 respectively. When adjusted for age, education, marital status, region, living arrangement,
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25 202 cooking, appetite status, ADL, DDS, BMI, the HRs (95% CI) were 0.43 (0.25–0.73), 0.63
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27 203 (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
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29 204 or 3 times a day. With further adjustment for financial status, the risk of mortality is reduced
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31 205 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
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33 206 ate with others 2 or 3 times a day.

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37 207 The pathway analyses are shown in Figure 1. For men, there are significant positive
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39 208 associations between eating-with-others frequency and dietary quality (DDS) ($p=0.006$) as
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41 209 well as mental health ($p=0.0009$). In turn, better dietary quality ($p<0.0001$) is associated with
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43 210 less mortality risk, as are physical functioning ($p<0.0001$) and general health ($p=0.007$). For
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45 211 women, eating-with-others is not associated with any of dietary quality, physical functioning,
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47 212 mental health or general health; however, dietary quality ($p=0.0004$) and physical functioning
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49 213 ($p<0.0001$) are inversely associated with mortality risk, while mental health ($p=0.043$) is
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51 214 positively associated.

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56 57 216 **DISCUSSION**

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4 217 This study explored the gender-specific associations between eating arrangement and risk of
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6 218 mortality by observing a population-representative older adult cohort with a 10-year follow-up
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8 219 in an Asian country. Eating-with-others was inversely associated with risk of mortality, more
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10 220 evident in men than in women.
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14 15 222 **Food intake when eating-with-others**

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17 223 Eating-with-others has numerous beneficial effects on health. A randomized controlled trial at
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19 224 a Dutch nursing home found that family-style meals that included the presence of others
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21 225 increased the energy intake and reduced the prevalence of malnutrition. Those who ate with
22
23 226 others ate more than those who ate alone. Social eating may stimulate intake through extension
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25 227 of meal duration and improved ambiance.⁸ The presence of others in the household did not
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27 228 affect energy intake, but the presence of others during mealtime did, with an average of 114
28
29 229 calories more per meal than those who ate alone.²⁵ Eating socially also improved dietary
30
31 230 quality and diversity.^{7,9} However, the present study shows that after control for dietary quality
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33 231 in the model, eating-with-others and mortality remains associated. A possible reason for this is
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35 232 that solitary eating is often associated with depression,⁴⁻⁶ in turn associated with mortality.
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37 233 However, there may be value in solitude itself which would be an alternative interpretation of
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39 234 the difference we have found in mortality risk reduction between eating twice and three times a
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41 235 day with others by men.
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47 48 237 **Eating-with-others and mortality**

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50 238 Our findings are consistent with several studies from Western countries. The Nutrition
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52 239 Screening Initiative (NSI) checklist, a tool for malnutrition screening and awareness in older
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54 240 adults in the US, asks questions regarding solitary eating. In a cohort study with 581
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56 241 community-dwelling older adults, who ate more than 17 meals alone per week, exhibited a
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4 242 2.07-fold higher risk of mortality (RR=2.07, 95% CI=1.49–2.86) over an 8–12-year period.¹³

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6 243 Another study in Botswana found that older adults who ate alone had a higher risk of death

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8 244 (OR=6.7, 95% CI=2.2–20.0).¹² But, gender effect was unknown in these studies.

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11 12 13 246 **Eating alone and gender**

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15 247 In the present study, men who ate with others had a lower risk of mortality than did those who

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17 248 ate alone, for several probable reasons. Men who ate with others had better dietary quality and a

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19 249 higher vegetable intake than those eating alone. We also found that men who ate alone were

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21 250 more likely to eat out, not prepare meals by themselves, and frequently skip meals than did

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23 251 women. A Japanese cohort study discovered that men who ate alone were more likely to be

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25 252 underweight and skip meals and less likely to eat fruits and vegetables.⁹ Underweight older

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27 253 adults with poor dietary quality and low fruit and vegetable intakes have been associated with a

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29 254 higher risk of mortality.^{10 26} Furthermore, in our study, eating out is often associated with

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31 255 high-fat foods with poor quality. Men who were solitary eaters had low carbohydrate, protein,

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33 256 dietary fiber, and other nutrient intakes, but a higher fat intake than those who ate with others,

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35 257 although the differences were non-significant.

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37 258 Compared with Japan,⁹ in our study men have a higher rate of solitary eating, but women

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39 259 have a lower rate. Taiwanese men who eat alone are more likely to be unmarried or live

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41 260 separately from their spouse. We found that the eating companionship of men who ate with

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43 261 others was usually their spouse or children rather than friends or neighbours (data not shown).

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45 262 Davis et al. found that dietary patterns of older men had stronger associations with living

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47 263 arrangements than did those of older women.²⁷ Cooking itself is a physical activity and a

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49 264 cognitive function,²⁸ and in Taiwanese culture women are more likely to prepare meals. Men

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51 265 eat out or buy ready-to-eat food more than they cook. In this study, men (47.0%) cooked less

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53 266 than did women (63.9%) when eating alone (Table 1). Men who ate alone shopped more than

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4 267 did women who ate alone (27.6% vs. 9.6%).
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6 268 It is also possible that what has been observed as a link between eating-with-others by
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8 269 men and survival is part of a bigger picture of the role of marriage and men living with a
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10 270 partner in their health outcomes and survival. It is well-documented that men who live with a
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12 271 female partner live longer than those who do not.^{29 30} This could be for any one or more of
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14 272 several reasons which include having a carer, companionship or sharing of duties. A
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16 273 correlation matrix (Supplementary table 1) shows that the greatest correlations with
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18 274 eating-with-others are for marital status (positive), living alone (negative), and cooking
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20 275 frequency (negative). In all three, the magnitude of the relationships is stronger for men.
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22 276 These covariates are included in our models. We have identified marital status and cooking as
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24 277 potential explanators for the difference in HRs between eating-with-others twice or three
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26 278 times a day by men.
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32 280 **Pathways from eating-with-others to survival**

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34 281 For men but not women, pathway analyses indicate that dietary quality, assessed as dietary
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36 282 diversity, provides a potential connection between the social aspect of eating-with-others and
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38 283 survival (Figure 1). This underscores the likely basic importance of nutritional factors in
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40 284 life-long health, but draws attention to the social as well as the biomedical role of food in
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42 285 health. For men, on pathway analysis, eating-with-others is associated with better mental
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44 286 health. Since pathway analysis requires that all independent variables are continuous, this may
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46 287 have resulted in an absence of a significant direct association of eating-with-others with
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48 288 mortality due to its frequency not being linearly related to mortality; this contrasts with the
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50 289 survival analyses by Cox regression (Table 4). In addition, by pathway analysis, each of
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52 290 physical functioning and general health are themselves important in the prediction of
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54 291 mortality risk in men. It remains conceivable that the dietary quality that men achieve,
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4 292 irrespective of eating-with-others, plays a role in each of physical functioning and general
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6 293 health, which is evident in this population.^{10 20}
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8 294 In the case of women, dietary quality directly and favourably predicts survival, but this
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10 295 connection is not found to be dependent on eating-with-others. Perhaps women can achieve
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12 296 the biomedical benefit of survival through diet without the need for its social function. In
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14 297 addition, women have a more favourable survival with better physical functioning. Somewhat
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16 298 surprisingly, better mental health is unfavourably associated with survival, although this is
17
18 299 weakly significant. It is possible that confounders that have not been considered in this
19
20 300 pathway analysis might account for this mental health association with mortality in older
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22 301 women. For example, in devoting themselves to the care of others, or in dealing successfully
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24 302 with a relative socio-economic disadvantage in widowhood, a sense of wellbeing may obtain,
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26 303 while health adversity supervenes.
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32 33 305 **Limitations**

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35 306 There are some limitations to this study. First, since the study participants were elderly, it can
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37 307 be expected that a change in their eating arrangements would take place through time as
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39 308 family and health circumstances change. Given that this is a single point survey (1999-2000),
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41 309 varied follow-up times may alter the findings. However, we have performed analyses with
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43 310 several follow-up times (<2, <4, <6 and ≥6 years) or the exclusion of events in the first and
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45 311 second years (data not shown). For men, the point estimates for HRs eating-with-others twice
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47 312 a day are consistently <1.00. But for women, low HRs of 0.15 are seen for eating-with-others
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49 313 once a day in the first two years of observation, although not beyond. This does not change
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51 314 our conclusions with the 10-year survival analysis. Second, the association may be affected by
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53 315 the duration of time spent eating alone or eating-with-others, which was not considered. Third,
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55 316 in Taiwanese society, older people are more likely to live with and depend on their families, so
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4 317 the culturally specific nature of this study may limit its applicability elsewhere. The study
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6 318 should be considered within a Taiwanese (of perhaps a broader Asian) context. As with cohort
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8 319 studies in general, there may have been confounders not considered which might have
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10 320 explained the associations presented. The study itself, however, has sought to consider the
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12 321 circumstances of eating which are usually neglected in the exploration of food and nutrient
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14 322 health relationships. The pathway analyses are an attempt to encompass more of the
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16 323 explanatory models for these relationships by way of inclusion of physical, mental and general
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18 324 health. The gender differences which are now recognised here and in other reports for the
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20 325 respective health roles of dietary quality on the one hand, and with whom the food is consumed
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22 326 on the other, are a challenge to more gender comprehensive public health policy.
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328 **Conclusions**

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

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17 348 YCH, HLC, MLW and MSL designed the study; YCH, HLC and YTCL performed statistical
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19 349 analysis; YCH, MLW, YTCL, and MSL wrote the paper; MSL had primary responsibility for
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26 376 **REFERENCES**

- 27
28 377 1. Rowe JW, Kahn RL. Successful aging. *Gerontologist* 1997;37:433–40.
- 29
30 378 2. Meiselman HL. Dimensions of the meal. *Journal of Foodservice* 2008;19:13–21. doi:
31
32 379 10.1111/j.1745-4506.2008.00076.x.
- 33
34 380 3. Administration for Community Living, US Department of Health and Human Services.
35
36 381 Nutrition Services (OAA Title IIIC) - Congregate Nutrition Services Washington, DC:
37
38 382 Administration for Community Living, US Department of Health and Human Services;
39
40 383 2016 [cited 2016 18th April]. Available from:
41
42 384 http://www.aoa.gov/AoA_programs/HPW/Nutrition_Services/index.aspx#congregate
43
44 385 accessed 18th April 2016.
- 45
46 386 4. Kuroda A, Tanaka T, Hirano H, *et al.* Eating alone as social disengagement is strongly
47
48 387 associated with depressive symptoms in Japanese community-dwelling older adults. *J*
49
50 388 *Am Med Dir Assoc* 2015;16:578–85. doi: 10.1016/j.jamda.2015.01.078.
- 51
52 389 5. Tani Y, Sasaki Y, Haseda M, *et al.* Eating alone and depression in older men and women
53
54 390 by cohabitation status: The JAGES longitudinal survey. *Age Ageing* 2015;44:1019-26.

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47
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- 391 doi: 10.1093/ageing/afv145.
- 392 6. Wang X, Shen W, Wang C, *et al.* Association between eating alone and depressive
393 symptom in elders: a cross-sectional study. *BMC Geriatr* 2016;16:19. doi:
394 10.1186/s12877-016-0197-2.
- 395 7. Kimura Y, Wada T, Okumiya K, *et al.* Eating alone among community-dwelling Japanese
396 elderly: association with depression and food diversity. *J Nutr Health Aging*
397 2012;16:728–31. doi: 10.1007/s12603-012-0067-3.
- 398 8. Nijs KA, de Graaf C, Siebelink E, *et al.* Effect of family-style meals on energy intake and
399 risk of malnutrition in dutch nursing home residents: a randomized controlled trial. *J*
400 *Gerontol A Biol Sci Med Sci* 2006;61:935–42.
- 401 9. Tani Y, Kondo N, Takagi D, *et al.* Combined effects of eating alone and living alone on
402 unhealthy dietary behaviors, obesity and underweight in older Japanese adults: Results
403 of the JAGES. *Appetite* 2015;95:1–8. doi: 10.1016/j.appet.2015.06.005.
- 404 10. Lee MS, Huang YC, Su HH, *et al.* A simple food quality index predicts mortality in
405 elderly Taiwanese. *J Nutr Health Aging* 2011;15:815–21.
- 406 11. Schoevers RA, Geerlings MI, Beekman AT, *et al.* Association of depression and gender
407 with mortality in old age. Results from the Amsterdam Study of the Elderly (AMSTEL).
408 *Br J Psychiatry* 2000;177:336–42.
- 409 12. Clausen T, Wilson AO, Molebatsi RM, *et al.* Diminished mental- and physical function
410 and lack of social support are associated with shorter survival in community dwelling
411 older persons of Botswana. *BMC Public Health* 2007;7:144. doi:
412 10.1186/1471-2458-7-144.
- 413 13. Sahyoun NR, Jacques PF, Dallal GE, *et al.* Nutrition Screening Initiative Checklist may
414 be a better awareness/educational tool than a screening one. *J Am Diet Assoc*
415 1997;97:760–4. doi: 10.1016/s0002-8223(97)00188-0.

- 1
2
3 416 14. Ek S. Gender differences in health information behaviour: a Finnish population-based
4
5 417 survey. *Health Promot Int* 2015;30:736–45. doi: 10.1093/heapro/dat063.
6
7 418 15. Redondo-Sendino A, Guallar-Castillon P, Banegas JR, *et al*. Gender differences in the
8
9 419 utilization of health-care services among the older adult population of Spain. *BMC*
10
11 420 *Public Health* 2006;6:155. doi: 10.1186/1471-2458-6-155.
12
13 421 16. Umberson D, Wortman CB, Kessler RC. Widowhood and depression: explaining
14
15 422 long-term gender differences in vulnerability. *J Health Soc Behav* 1992;33:10–24.
16
17 423 17. Wu SJ, Chang YH, Wei IL, *et al*. Intake levels and major food sources of energy and
18
19 424 nutrients in the Taiwanese elderly. *Asia Pac J Clin Nutr* 2005;14:211–20.
20
21 425 18. Cheng SL. Eating-with-others and the health of older people. School of Public Health.
22
23 426 National Defense Medical Center, 2014.
24
25 427 19. Huang YC, Lee MS, Pan WH, *et al*. Validation of a simplified food frequency
26
27 428 questionnaire as used in the Nutrition and Health Survey in Taiwan (NAHSIT) for the
28
29 429 elderly. *Asia Pac J Clin Nutr* 2011;20:134–40.
30
31 430 20. Lee MS, Chen RCY, Chang YH, *et al*. Physical function mitigates the adverse effects of
32
33 431 being thin on mortality in a freelifing older Taiwanese cohort. *J Nutr Health Aging*
34
35 432 2012;16:766–83.
36
37 433 21. Chuang S, Chang H, Lee M, *et al*. Skeletal muscle mass and risk of death in an elderly
38
39 434 population. *Nutr, Metab Cardiovasc Di* 2014;24:784–91.
40
41 435 22. Charlson ME, Pompei P, Ales KL, *et al*. A new method of classifying prognostic
42
43 436 comorbidity in longitudinal studies. Development and validation. *J Chronic Dis*
44
45 437 1987;40:373–83.
46
47 438 23. Chen RC, Chang YH, Lee MS, *et al*. Dietary quality may enhance survival related to
48
49 439 cognitive impairment in Taiwanese elderly. *Food Nutr Res* 2011;55 doi:
50
51 440 10.3402/fnr.v55i0.7387.
52
53
54
55
56
57
58
59
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60

- 441 24. Gamborg M, Jensen GB, Sorensen TI, *et al.* Dynamic path analysis in life-course
442 epidemiology. *Am J Epidemiol* 2011;173:1131–9. doi: 10.1093/aje/kwq502.
- 443 25. Locher JL, Robinson CO, Roth DL, *et al.* The effect of the presence of others on caloric
444 intake in homebound older adults. *J Gerontol A Biol Sci Med Sci* 2005;60:1475-8.
- 445 26. Trichopoulou A, Kouris-Blazos A, Wahlqvist ML, *et al.* Diet and overall survival in
446 elderly people. *BMJ* 1995;311:1457–60.
- 447 27. Davis MA, Randall E, Forthofer RN, *et al.* Living arrangements and dietary patterns of
448 older adults in the United States. *J Gerontol* 1985;40:434-42.
- 449 28. Chen RC, Lee MS, Chang YH, *et al.* Cooking frequency may enhance survival in
450 Taiwanese elderly. *Public Health Nutr* 2012;15:1142–9. doi:
451 10.1017/s136898001200136x.
- 452 29. Ng TP, Jin A, Feng L, *et al.* Mortality of older persons living alone: Singapore
453 Longitudinal Ageing Studies. *BMC Geriatr* 2015;15:126. doi:
454 10.1186/s12877-015-0128-7.
- 455 30. Bowling A. Mortality after bereavement: a review of the literature on survival periods and
456 factors affecting survival. *Soc Sci Med* 1987;24:117–24.

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3 459 **LEGENDS**

4
5 460 Figure 1. Pathway analysis for the associations of eating-with-others and all-cause mortality.

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7 461 All values are presented as β coefficients with their p values.

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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

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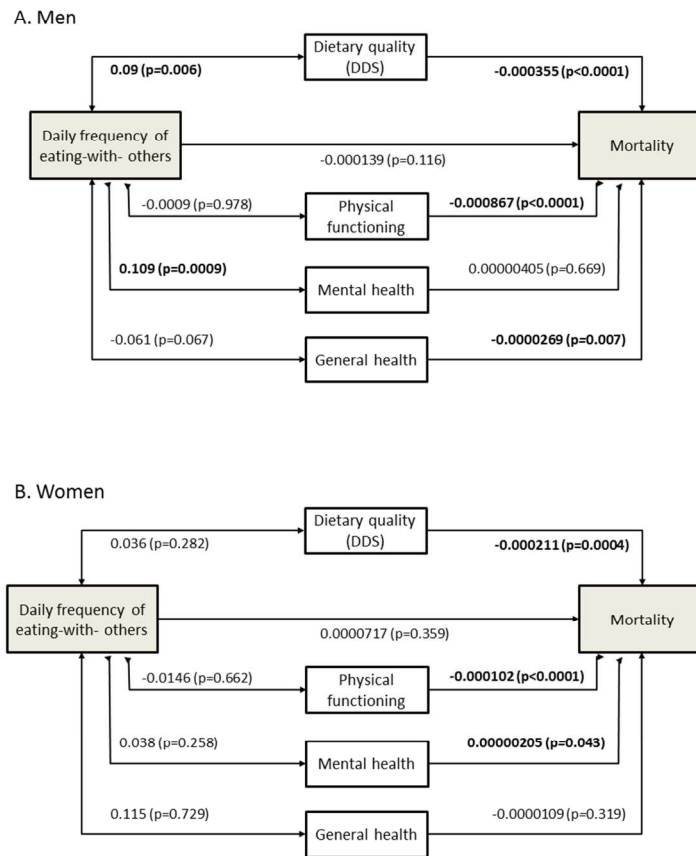


Figure 1. Pathway analysis for the associations of eating-with-others and all-cause mortality. All values are presented as β coefficients with their p values.

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) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —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 <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants	5, 7
		(b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> —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) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed <i>Cross-sectional study</i> —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) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)	Table 1
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time	Table 4
		<i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure	
		<i>Cross-sectional study</i> —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
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*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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4 1 **TITLE PAGE**5
6
7 2 **Gender differences in longevity in free-living older adults who**
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9 3 **eat-with-others: a prospective study in Taiwan**10
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12 4
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14
15 5 Yi-Chen Huang^{1,2}, Hsing-Ling Cheng³, Mark L Wahlqvist^{2,4,5}, Yuan-Ting C Lo², Meei-Shyuan
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48 25
49
50 26 Word count: 3132 words (excluding title page, licence statement, abstract, references, figures
51 27 and tables)

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3
4 28 **ABSTRACT**

5
6 29 **Objectives:** Social activities such as ‘eating-with-others’ can positively affect the ageing
7
8
9 30 process. We investigated the gender-specific association between eating arrangements and risk
10
11 31 of all-cause mortality among free-living older adults.

12
13 32 **Setting:** A representative sample from the elderly Nutrition and Health Survey in Taiwan
14
15 33 during 1999-2000.

16
17 34 **Participants:** Some 1,894 participants (955 men and 939 women) who aged ≥ 65 and
18
19 35 completed eating arrangement question as well as confirmed survivorship information.

20
21 36 **Primary and secondary outcome measures:** Eating arrangements, health condition, and
22
23 37 24-hour dietary recall information were collected at baseline. We classified eating
24
25 38 arrangements as the daily frequency of eating-with-others (0–3). Survivorship was determined
26
27 39 by the National Death Registry until the end of 2008. Cox proportional-hazards regression was
28
29 40 used to assess the association between eating-with-others and mortality risk.

30
31 41 **Results:** Overall, 63.1% of men and 56.4% of women ate with others 3 times a day. Both men
32
33 42 and women who ate with others were more likely to have higher meat and vegetable intakes,
34
35 43 and greater dietary quality than those who ate alone. The hazard ratios (HRs) (95% CI) for
36
37 44 all-cause mortality when eating-with-others 2 and 3 times daily were 0.46 (0.28–0.61), 0.67
38
39 45 (0.52–0.88) in men and 0.68 (0.42–1.11), 0.86 (0.64–1.16) in women, compared with those
40
41 46 who ate alone. Multivariable HRs (95% CI) adjusted for sociodemographic, nutritional and
42
43 47 “activities of daily living” covariates were 0.43 (0.25–0.73), 0.63 (0.41–0.98) in men and 0.68
44
45 48 (0.35–1.30), 0.69 (0.39–1.21) in women. With further adjustment for financial status, HR was
46
47 49 reduced by 54% in men who ate with others twice a day. Pathway analysis shows this to be
48
49 50 dependent on improved dietary quality by eating-with-others.

50
51 51 **Conclusions:** Eating-with-others is an independent survival factor in older men. To providing
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53 52 a social environment which encourages eating-with-others may benefit survival of older
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4 53 people, especially for men.
5

6 54 **Key words:** elderly, diet, mortality, social activities
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10
11 56 **STRENGTHS AND LIMITATIONS OF THIS STUDY**

12
13 57 ● Use of a representative free-living Taiwanese cohort with 10 years' follow-up for
14
15 58 survival.

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17 59 ● Study design provided an understanding of eating arrangements for older adults in a
18
19 60 community setting.

20
21 61 ● A comprehensive assessment of the gender-specific associations between
22
23 62 eating-with-others and mortality for older adults.

24
25 63 ● The frequency, but not duration of time spent eating alone or eating-with-others was
26
27 64 considered.

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29 65 ● Participants were mainly of Chinese ethnicity from Taiwan so that the generalisability of
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31 66 findings may be limited.
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68 INTRODUCTION

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

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

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

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

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4 93 Taiwanese cohort of older men and women.
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12 95 **SUBJECTS AND METHODS**

13 96 **Participants**

14 97 Participants aged 65 and over were recruited from the Elderly Nutrition and Health Survey in
15 98 Taiwan during 1999–2000. The details of the survey design and sampling method have been
16 99 published elsewhere.¹⁷ In total, 1,937 older people completed face-to-face interviews with
17 100 trained interviewers. We excluded 40 participants with incorrect identification or incorrect
18 101 identity numbers and those who did not provide relevant or required information. After which
19 102 1,894 participants (955 men and 939 women) remained in the study. Trained interviewers
20 103 collected data on sociodemographics, dietary habits and intake, and disease history. All
21 104 participants signed informed consent forms prior to being interviewed. This project was
22 105 approved by the Ethics Committees of the National Health Research Institute and Academia
23 106 Sinica, Taiwan.
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108 **Eating arrangement**

109 Eating arrangements were assessed by asking participants whether they usually ate breakfast,
110 lunch, and dinner with others. Their responses were recorded as one of the following four
111 options: eat alone, eat with spouse, eat with children or relative(s), and eat with friend(s) or
112 neighbor(s). We then classified the eating arrangements as eating-with-others 0 (eat alone), 1,
113 2, 3 times a day.¹⁸ Information was also obtained about the person responsible for meal
114 preparation.

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116 **Dietary assessment**

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

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4 118 frequency questionnaire.¹⁹ Dietary quality and nutritional intake were measured through
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6 119 one-day 24-hour dietary recall. The dietary quality was evaluated using the dietary diversity
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8 120 score (DDS), which is based on the consumption of a half serving of the following six food
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10 121 groups daily: grains; meat, fish, or eggs; dairy; vegetables; fruits; and oil or fat. The DDS
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12 122 score ranges from 0 to 6, with a higher score representing higher dietary quality. The method
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14 123 of nutrient intake calculation is described elsewhere.¹⁰
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20 **Other variables**

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22 126 Participants were also asked how frequently they cooked or aided with cooking (excluding
23
24 127 ready-to-eat meals), and their responses were recorded as never, sometimes, often, or usually.
25
26 128 Participants were then asked how many people they lived with. The response “0” was defined
27
28 129 as living alone.

30
31 130 Health-related quality of life was measured by a 36 item Short Form (SF-36) in a
32
33 131 validated traditional Chinese version. A total of 8 dimensions of health, included physical
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35 132 functioning, role limitations due to physical problems, mental health, role limitations due to
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37 133 emotional problems, social function, bodily pain, vitality and general health. The score was
38
39 134 calculated by the norm-based scoring system ($\mu=50$, $\sigma=10$) and standardised. Higher scores
40
41 135 indicated a better quality of life.²⁰
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44 136 Disability was evaluated by activities of daily living (ADL) which included 9 questions
45
46 137 about self-care task difficulty in an older adult’s daily life. We used bioelectrical impedance
47
48 138 analysis to measure muscle mass. The skeletal muscle mass index was used to determine
49
50 139 sarcopenia status, calculated with the following equation:²¹

$$51 \quad [0.401 \times (\text{height}^2 / \text{resistance}) + (3.825 \times \text{gender}) - (0.071 \times \text{age}) + 5.102] / \text{height}^2$$

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53 140 where height is measured in metres, resistance in Ohms, and age in years; men = 1 and
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55 141 women = 0.
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4 143 The Charlson comorbidity index was used to assess multi-morbidity.²² Cognitive function
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6 144 was assessed by a validated Short Portable Mental Status Questionnaire (SPMSQ) in Chinese
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8 145 which included 10 questions about orientation in time and place, personal history, long-term
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10 146 and short-term memory and calculation. More than or equal to three erroneous responses was
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12 147 regarded as cognitive impairment.²³
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18 149 **Outcome ascertainment**

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20 150 National Death Registry data were obtained from Taiwan's Ministry of Health and Welfare.
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22 151 We linked the NAHSIT dataset to the National Death Registry dataset using the participant ID
23
24 152 to determine survival rates. Follow-up time was calculated from date of interview to date of
25
26 153 death or until December 31, 2008.
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30 155 **Statistical analysis**

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33 156 Categorical variables and continuous variables were presented as n (%) or mean \pm standard
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35 157 errors (SE). Chi-square and ANOVA were used to determine the association between eating
36
37 158 arrangements and baseline characteristics for categorical or continuous variables, respectively.
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39 159 The Cox proportional-hazards regression model was used to evaluate the association between
40
41 160 daily frequency eating-with-others and risk of all-cause mortality. Since the interaction
42
43 161 between eating arrangements and gender was significant ($p=0.0093$), we used gender-specific
44
45 162 analyses. Additional factors were age, education level, marital status, region, living
46
47 163 arrangement, BMI, DDS, cooking frequency, appetite status, ADL and self-rate financial
48
49 164 status. All data analyses were performed using SAS 9.2 and SUDAAN 9.0 to adjust for the
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51 165 design effect of sampling.
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55 166 To explore the pathways which might connect eating-with-others to survival, we have
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57 167 considered the intermediates of dietary quality (DDS), physical functioning, mental health,
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4 168 and general health. The first linkage, using continuous variables, has been assessed by
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6 169 Pearson's partial correlation coefficients. The second linkage to risk of mortality, as
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8 170 coefficients, has been assessed by the Aalen additive hazards model.²⁴
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10 171

11 12 13 172 **RESULTS**

14
15 173 In total, 63.1% of men and 56.4% of women ate with others 3 times a day. For both genders,
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17 174 those who ate with others were more likely to be younger, married, better financial status,
18
19 175 living with others, and less cooking than were those who ate alone. Men who ate alone had
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21 176 significantly higher ADLs ($p=0.004$) and cognitive impairment ($p=0.005$) than those who ate
22
23 177 with others. (Table 1)

24
25
26 178 Table 2 presents the dietary quality and food intakes for daily frequency of
27
28 179 eating-with-others by gender. Those who ate alone had a poor dietary quality ($DDS \leq 3$),
29
30 180 compared to those who ate with others 3 times daily. Men who ate alone ate less meat (1.02 vs.
31
32 181 1.30 times/d) and vegetables (1.90 vs. 2.47 times/d) than did those who ate with others 3
33
34 182 times a day ($p<0.05$). Women who ate with others 3 times a day tended to eat more meat (1.13
35
36 183 vs 0.81 times/d), seafood (0.99 vs. 0.70 times/d), eggs (0.38 vs. 0.23 times/d), and vegetable
37
38 184 (2.52 vs. 2.09 times/d) intake than did those who ate alone ($p<0.05$). Further, women who ate
39
40 185 alone had lower fat (24.7 vs. 28.9 g/1000 kcal/d) intakes, but higher carbohydrate (155 vs. 144
41
42 186 g/1000 kcal/d) intakes compared with those who ate with others ($p<0.05$). Regarding meals,
43
44 187 around 58% to 60% of men and 68% to 74% of women prepared meals by themselves when
45
46 188 eating alone. Men were more likely to eat out when eating-with-others once a day compared
47
48 189 with women.

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53 190 Men who ate with others twice per day have significantly high physical functioning
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55 191 compared with other groups ($p=0.044$). For women, who ate with others once per day have
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57 192 higher physical functioning (50.7 vs. 45.2) and role limitations due to physical problem (51.4
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4 193 vs. 46.1) compared with those who ate alone. (Table 3)

5
6 194 Table 4 presents the association between daily frequency eating-with-others and risk of
7
8 195 all-cause mortality by gender. In the crude model, the HRs (95% CI) of risk of all-cause
9
10 196 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)
11
12 197 in men and 0.68 (0.42–1.11), 0.86 (0.64–1.16) in women compared with those who ate alone,
13
14 198 respectively. When adjusted for age, education, marital status, region, living arrangement,
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16 199 cooking, appetite status, ADL, DDS, BMI, the HRs (95% CI) were 0.43 (0.25–0.73), 0.63
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18 200 (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
19
20 201 or 3 times a day. With further adjustment for financial status, the risk of mortality is reduced
21
22 202 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
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24 203 ate with others 2 or 3 times a day.
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28 204 The pathway analyses are shown in Figure 1. For men, there are significant positive
29
30 205 associations between eating-with-others frequency and dietary quality (DDS) ($p=0.006$) as
31
32 206 well as mental health ($p=0.0009$). In turn, better dietary quality ($p<0.0001$) is associated with
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34 207 less mortality risk, as are physical functioning ($p<0.0001$) and general health ($p=0.007$). For
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36 208 women, eating-with-others is not associated with any of dietary quality, physical functioning,
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38 209 mental health or general health; however, dietary quality ($p=0.0004$) and physical functioning
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40 210 ($p<0.0001$) are inversely associated with mortality risk, while mental health ($p=0.043$) is
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42 211 positively associated.
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47 48 213 **DISCUSSION**

49
50 214 This study explored the gender-specific associations between eating arrangement and risk of
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52 215 mortality by observing a population-representative older adult cohort with a 10-year follow-up
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54 216 in an Asian country. Eating-with-others was inversely associated with risk of mortality, more
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56 217 evident in men than in women.
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6 219 **Food intake when eating-with-others**

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8 220 Eating-with-others has numerous beneficial effects on health. A randomized controlled trial at
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10 221 a Dutch nursing home found that family-style meals that included the presence of others
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12 222 increased the energy intake and reduced the prevalence of malnutrition. Those who ate with
13
14 223 others ate more than those who ate alone. Social eating may stimulate intake through extension
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16 224 of meal duration and improved ambiance.⁸ The presence of others in the household did not
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18 225 affect energy intake, but the presence of others during mealtime did, with an average of 114
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20 226 calories more per meal than those who ate alone.²⁵ Eating socially also improved dietary
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22 227 quality and diversity.^{7,9} However, the present study shows that after control for dietary quality
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24 228 in the model, eating-with-others and mortality remains associated. A possible reason for this is
25
26 229 that solitary eating is often associated with depression,^{4,6} in turn associated with mortality.
27
28 230 However, there may be value in solitude itself which would be an alternative interpretation of
29
30 231 the difference we have found in mortality risk reduction between eating twice and three times a
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32 232 day with others by men.
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40 234 **Eating-with-others and mortality**

41 235 Our findings are consistent with several studies from Western countries. The Nutrition
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43 236 Screening Initiative (NSI) checklist, a tool for malnutrition screening and awareness in older
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45 237 adults in the US, asks questions regarding solitary eating. In a cohort study with 581
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47 238 community-dwelling older adults, who ate more than 17 meals alone per week, exhibited a
48
49 239 2.07-fold higher risk of mortality (RR=2.07, 95% CI=1.49–2.86) over an 8–12-year period.¹³
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51 240 Another study in Botswana found that older adults who ate alone had a higher risk of death
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53 241 (OR=6.7, 95% CI=2.2–20.0).¹² But, gender effect was unknown in these studies.
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4 243 **Eating alone and gender**
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6 244 In the present study, men who ate with others had a lower risk of mortality than did those who
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8 245 ate alone, for several probable reasons. Men who ate with others had better dietary quality and a
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10 246 higher vegetable intake than those eating alone. We also found that men who ate alone were
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12 247 more likely to eat out, not prepare meals by themselves, and frequently skip meals than did
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15 248 women. A Japanese cohort study discovered that men who ate alone were more likely to be
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17 249 underweight and skip meals and less likely to eat fruits and vegetables.⁹ Underweight older
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19 250 adults with poor dietary quality and low fruit and vegetable intakes have been associated with a
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21 251 higher risk of mortality.^{10 26} Furthermore, in our study, eating out is often associated with
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23 252 high-fat foods with poor quality. Men who were solitary eaters had low carbohydrate, protein,
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25 253 dietary fiber, and other nutrient intakes, but a higher fat intake than those who ate with others,
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28 254 although the differences were non-significant.

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30 255 Compared with Japan,⁹ in our study men have a higher rate of solitary eating, but women
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32 256 have a lower rate. Taiwanese men who eat alone are more likely to be unmarried or live
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34 257 separately from their spouse. We found that the eating companionship of men who ate with
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36 258 others was usually their spouse or children rather than friends or neighbours (data not shown).
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38 259 Davis et al. found that dietary patterns of older men had stronger associations with living
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40 260 arrangements than did those of older women.²⁷ Cooking itself is a physical activity and a
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42 261 cognitive function,²⁸ and in Taiwanese culture women are more likely to prepare meals. Men
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44 262 eat out or buy ready-to-eat food more than they cook. In this study, men (47.0%) cooked less
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46 263 than did women (63.9%) when eating alone (Table 1). Men who ate alone shopped more than
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48 264 did women who ate alone (27.6% vs. 9.6%).

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52 265 It is also possible that what has been observed as a link between eating-with-others by
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54 266 men and survival is part of a bigger picture of the role of marriage and men living with a
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56 267 partner in their health outcomes and survival. It is well-documented that men who live with a

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4 268 female partner live longer than those who do not.^{29 30} This could be for any one or more of
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6 269 several reasons which include having a carer, companionship or sharing of duties. A
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8 270 correlation matrix (Supplementary table 1) shows that the greatest correlations with
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10 271 eating-with-others are for marital status (positive), living alone (negative), and cooking
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12 272 frequency (negative). In all three, the magnitude of the relationships is stronger for men.
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14 273 These covariates are included in our models. We have identified marital status and cooking as
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16 274 potential explanators for the difference in HRs between eating-with-others twice or three
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18 275 times a day by men.
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23 24 277 **Pathways from eating-with-others to survival**

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26 278 For men but not women, pathway analyses indicate that dietary quality, assessed as dietary
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28 279 diversity, provides a potential connection between the social aspect of eating-with-others and
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30 280 survival (Figure 1). This underscores the likely basic importance of nutritional factors in
31
32 281 life-long health, but draws attention to the social as well as the biomedical role of food in
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34 282 health. For men, on pathway analysis, eating-with-others is associated with better mental
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36 283 health. Since pathway analysis requires that all independent variables are continuous, this may
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38 284 have resulted in an absence of a significant direct association of eating-with-others with
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40 285 mortality due to its frequency not being linearly related to mortality; this contrasts with the
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42 286 survival analyses by Cox regression (Table 4). In addition, by pathway analysis, each of
43
44 287 physical functioning and general health are themselves important in the prediction of
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46 288 mortality risk in men. It remains conceivable that the dietary quality that men achieve,
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48 289 irrespective of eating-with-others, plays a role in each of physical functioning and general
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50 290 health, which is evident in this population.^{10 20}
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55 291 In the case of women, dietary quality directly and favourably predicts survival, but this
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57 292 connection is not found to be dependent on eating-with-others. Perhaps women can achieve
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4 293 the biomedical benefit of survival through diet without the need for its social function. In
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6 294 addition, women have a more favourable survival with better physical functioning. Somewhat
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8 295 surprisingly, better mental health is unfavourably associated with survival, although this is
9
10 296 weakly significant. It is possible that confounders that have not been considered in this
11
12 297 pathway analysis might account for this mental health association with mortality in older
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14 298 women. For example, in devoting themselves to the care of others, or in dealing successfully
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16 299 with a relative socio-economic disadvantage in widowhood, a sense of wellbeing may obtain,
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18 300 while health adversity supervenes.
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23 302 **Limitations**

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26 303 There are some limitations to this study. First, since the study participants were elderly, it can
27
28 304 be expected that a change in their eating arrangements would take place through time as
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30 305 family and health circumstances change. Given that this is a single point survey (1999-2000),
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32 306 varied follow-up times may alter the findings. However, we have performed analyses with
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34 307 several follow-up times (<2, <4, <6 and ≥6 years) or the exclusion of events in the first and
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36 308 second years (data not shown). For men, the point estimates for HRs eating-with-others twice
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38 309 a day are consistently <1.00. But for women, low HRs of 0.15 are seen for eating-with-others
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40 310 once a day in the first two years of observation, although not beyond. This does not change
41
42 311 our conclusions with the 10-year survival analysis. Second, the association may be affected by
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44 312 the duration of time spent eating alone or eating-with-others, which was not considered. Third,
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46 313 in Taiwanese society, older people are more likely to live with and depend on their families, so
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48 314 the culturally specific nature of this study may limit its applicability elsewhere. The study
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50 315 should be considered within a Taiwanese (of perhaps a broader Asian) context. As with cohort
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52 316 studies in general, there may have been confounders not considered which might have
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54 317 explained the associations presented. The study itself, however, has sought to consider the
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4 318 circumstances of eating which are usually neglected in the exploration of food and nutrient
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6 319 health relationships. The pathway analyses are an attempt to encompass more of the
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8 320 explanatory models for these relationships by way of inclusion of physical, mental and general
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10 321 health. The gender differences which are now recognised here and in other reports for the
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12 322 respective health roles of dietary quality on the one hand, and with whom the food is consumed
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14 323 on the other, are a challenge to more gender comprehensive public health policy.
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19 20 325 **Conclusions**

21
22 326 Eating socially may benefit survival in elderly men through the adjunct of dietary quality; it is
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24 327 also positively associated with men's mental health. For women, dietary quality is associated
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26 328 with survival advantage which is not apparently dependent on eating-with-others. The relative
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28 329 gender advantage in longevity that women have in this population is not adequately explained
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30 330 in the present study, except that they are likely to be the ones who eat with men who benefit
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32 331 from this social role of food. Thus, for men and women, the provision of a healthy social
33
34 332 environment which increases social interactions should improve health outcomes.
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43
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45
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47
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49
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51
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53
54 341 represent those of Department of Health, or National Health Research Institutes.

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56 342 None of the authors has any conflicts of interest to declare.
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7 344 **AUTHOR'S CONTRIBUTION**

8
9 345 YCH, HLC, MLW and MSL designed the study; YCH, HLC and YTCL performed statistical
10
11 346 analysis; YCH, MLW, YTCL, and MSL wrote the paper; MSL had primary responsibility for
12
13 347 the final content.
14

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18 349 **COMPETING INTERESTS**

19
20 350 No author has any conflict of interest in regard to this paper.
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31 355 Sciences Institute (ILSI) Taiwan.
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36 357 **DATA SHARING STATEMENT**

37
38 358 No additional data are available.
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41

42 360 **ETHICS**

43
44 361 This project was approved by the Ethics Committees of the National Health Research Institute

45
46 362 and Academia Sinica, Taiwan.
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15
16
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18 373 REFERENCES

- 19 374 1. Rowe JW, Kahn RL. Successful aging. *Gerontologist* 1997;37:433–40.
20
21 375 2. Meiselman HL. Dimensions of the meal. *Journal of Foodservice* 2008;19:13–21. doi:
22
23 376 10.1111/j.1745-4506.2008.00076.x.
24
25 377 3. Administration for Community Living, US Department of Health and Human Services.
26
27 378 Nutrition Services (OAA Title IIIC) - Congregate Nutrition Services Washington, DC:
28
29 379 Administration for Community Living, US Department of Health and Human Services;
30
31 380 2016 [cited 2016 18th April]. Available from:
32
33 381 http://www.aoa.gov/AoA_programs/HPW/Nutrition_Services/index.aspx#congregate
34
35 382 accessed 18th April 2016.
36
37 383 4. Kuroda A, Tanaka T, Hirano H, *et al.* Eating alone as social disengagement is strongly
38
39 384 associated with depressive symptoms in Japanese community-dwelling older adults. *J*
40
41 385 *Am Med Dir Assoc* 2015;16:578–85. doi: 10.1016/j.jamda.2015.01.078.
42
43 386 5. Tani Y, Sasaki Y, Haseda M, *et al.* Eating alone and depression in older men and women
44
45 387 by cohabitation status: The JAGES longitudinal survey. *Age Ageing* 2015;44:1019-26.
46
47 388 doi: 10.1093/ageing/afv145.
48
49 389 6. Wang X, Shen W, Wang C, *et al.* Association between eating alone and depressive
50
51 390 symptom in elders: a cross-sectional study. *BMC Geriatr* 2016;16:19. doi:
52
53 391 10.1186/s12877-016-0197-2.
54
55
56
57
58
59
60

- 1
2
3 392 7. Kimura Y, Wada T, Okumiya K, *et al.* Eating alone among community-dwelling Japanese
4
5 393 elderly: association with depression and food diversity. *J Nutr Health Aging*
6
7 394 2012;16:728–31. doi: 10.1007/s12603-012-0067-3.
8
9
10 395 8. Nijs KA, de Graaf C, Siebelink E, *et al.* Effect of family-style meals on energy intake and
11
12 396 risk of malnutrition in dutch nursing home residents: a randomized controlled trial. *J*
13
14 397 *Gerontol A Biol Sci Med Sci* 2006;61:935–42.
15
16 398 9. Tani Y, Kondo N, Takagi D, *et al.* Combined effects of eating alone and living alone on
17
18 399 unhealthy dietary behaviors, obesity and underweight in older Japanese adults: Results
19
20 400 of the JAGES. *Appetite* 2015;95:1–8. doi: 10.1016/j.appet.2015.06.005.
21
22
23 401 10. Lee MS, Huang YC, Su HH, *et al.* A simple food quality index predicts mortality in
24
25 402 elderly Taiwanese. *J Nutr Health Aging* 2011;15:815–21.
26
27 403 11. Schoevers RA, Geerlings MI, Beekman AT, *et al.* Association of depression and gender
28
29 404 with mortality in old age. Results from the Amsterdam Study of the Elderly (AMSTEL).
30
31 405 *Br J Psychiatry* 2000;177:336–42.
32
33
34 406 12. Clausen T, Wilson AO, Molebatsi RM, *et al.* Diminished mental- and physical function
35
36 407 and lack of social support are associated with shorter survival in community dwelling
37
38 408 older persons of Botswana. *BMC Public Health* 2007;7:144. doi:
39
40 409 10.1186/1471-2458-7-144.
41
42
43 410 13. Sahyoun NR, Jacques PF, Dallal GE, *et al.* Nutrition Screening Initiative Checklist may
44
45 411 be a better awareness/educational tool than a screening one. *J Am Diet Assoc*
46
47 412 1997;97:760–4. doi: 10.1016/s0002-8223(97)00188-0.
48
49
50 413 14. Ek S. Gender differences in health information behaviour: a Finnish population-based
51
52 414 survey. *Health Promot Int* 2015;30:736–45. doi: 10.1093/heapro/dat063.
53
54 415 15. Redondo-Sendino A, Guallar-Castillon P, Banegas JR, *et al.* Gender differences in the
55
56 416 utilization of health-care services among the older adult population of Spain. *BMC*

- 1
2
3 417 *Public Health* 2006;6:155. doi: 10.1186/1471-2458-6-155.
- 4
5 418 16. Umberson D, Wortman CB, Kessler RC. Widowhood and depression: explaining
6
7 419 long-term gender differences in vulnerability. *J Health Soc Behav* 1992;33:10–24.
- 8
9 420 17. Wu SJ, Chang YH, Wei IL, *et al.* Intake levels and major food sources of energy and
10
11 421 nutrients in the Taiwanese elderly. *Asia Pac J Clin Nutr* 2005;14:211–20.
- 12
13 422 18. Cheng SL. Eating-with-others and the health of older people. School of Public Health.
14
15 423 National Defense Medical Center, 2014.
- 16
17 424 19. Huang YC, Lee MS, Pan WH, *et al.* Validation of a simplified food frequency
18
19 425 questionnaire as used in the Nutrition and Health Survey in Taiwan (NAHSIT) for the
20
21 426 elderly. *Asia Pac J Clin Nutr* 2011;20:134–40.
- 22
23 427 20. Lee MS, Chen RCY, Chang YH, *et al.* Physical function mitigates the adverse effects of
24
25 428 being thin on mortality in a freeliving older Taiwanese cohort. *J Nutr Health Aging*
26
27 429 2012;16:766–83.
- 28
29 430 21. Chuang S, Chang H, Lee M, *et al.* Skeletal muscle mass and risk of death in an elderly
30
31 431 population. *Nutr, Metab Cardiovasc Di* 2014;24:784–91.
- 32
33 432 22. Charlson ME, Pompei P, Ales KL, *et al.* A new method of classifying prognostic
34
35 433 comorbidity in longitudinal studies. Development and validation. *J Chronic Dis*
36
37 434 1987;40:373–83.
- 38
39 435 23. Chen RC, Chang YH, Lee MS, *et al.* Dietary quality may enhance survival related to
40
41 436 cognitive impairment in Taiwanese elderly. *Food Nutr Res* 2011;55 doi:
42
43 437 10.3402/fnr.v55i0.7387.
- 44
45 438 24. Gamborg M, Jensen GB, Sorensen TI, *et al.* Dynamic path analysis in life-course
46
47 439 epidemiology. *Am J Epidemiol* 2011;173:1131–9. doi: 10.1093/aje/kwq502.
- 48
49 440 25. Locher JL, Robinson CO, Roth DL, *et al.* The effect of the presence of others on caloric
50
51 441 intake in homebound older adults. *J Gerontol A Biol Sci Med Sci* 2005;60:1475-8.
- 52
53
54
55
56
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51
52
53
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56
57
58
59
60

- 442 26. Trichopoulou A, Kouris-Blazos A, Wahlqvist ML, *et al.* Diet and overall survival in
443 elderly people. *BMJ* 1995;311:1457–60.
- 444 27. Davis MA, Randall E, Forthofer RN, *et al.* Living arrangements and dietary patterns of
445 older adults in the United States. *J Gerontol* 1985;40:434-42.
- 446 28. Chen RC, Lee MS, Chang YH, *et al.* Cooking frequency may enhance survival in
447 Taiwanese elderly. *Public Health Nutr* 2012;15:1142–9. doi:
448 10.1017/s136898001200136x.
- 449 29. Ng TP, Jin A, Feng L, *et al.* Mortality of older persons living alone: Singapore
450 Longitudinal Ageing Studies. *BMC Geriatr* 2015;15:126. doi:
451 10.1186/s12877-015-0128-7.
- 452 30. Bowling A. Mortality after bereavement: a review of the literature on survival periods and
453 factors affecting survival. *Soc Sci Med* 1987;24:117–24.
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3 456 **LEGEND**

4
5 457 Figure 1. Gender-specific pathway analysis for the associations of eating-with-others and
6
7 458 all-cause mortality. All values are presented as β coefficients with their p values. (A) men; (B)
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9 459 women.
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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/m²)

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

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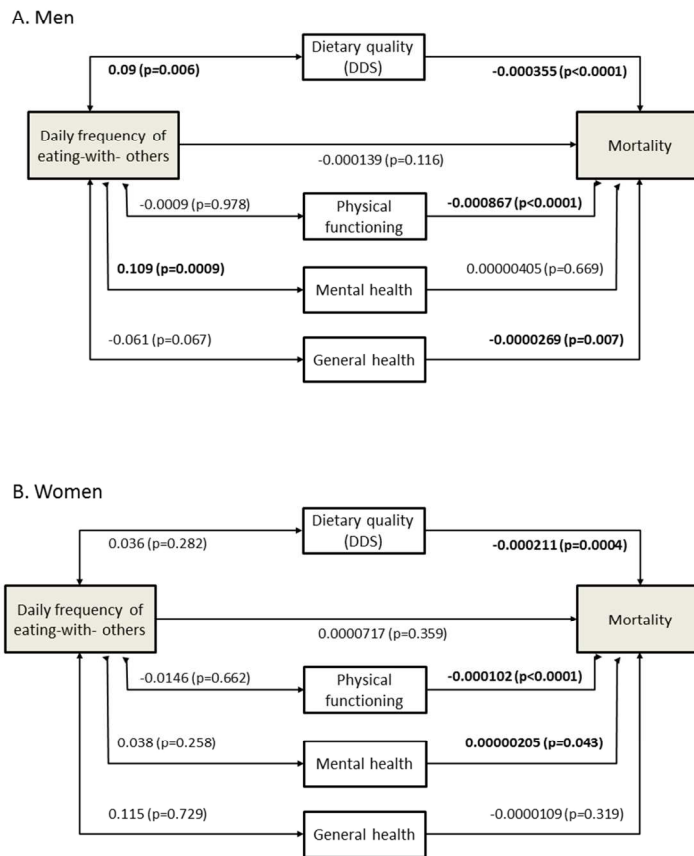


Figure 1. Gender-specific pathway analysis for the associations of eating-with-others and all-cause mortality. All values are presented as β coefficients with their p values. (A) men; (B) women.

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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) <i>Cohort study</i> —Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up <i>Case-control study</i> —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 <i>Cross-sectional study</i> —Give the eligibility criteria, and the sources and methods of selection of participants	5, 7
		(b) <i>Cohort study</i> —For matched studies, give matching criteria and number of exposed and unexposed <i>Case-control study</i> —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) <i>Cohort study</i> —If applicable, explain how loss to follow-up was addressed <i>Case-control study</i> —If applicable, explain how matching of cases and controls was addressed <i>Cross-sectional study</i> —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) <i>Cohort study</i> —Summarise follow-up time (eg, average and total amount)	Table 1
Outcome data	15*	<i>Cohort study</i> —Report numbers of outcome events or summary measures over time	Table 4
		<i>Case-control study</i> —Report numbers in each exposure category, or summary measures of exposure	
		<i>Cross-sectional study</i> —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
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*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.