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## Which Aging Group Prone to Have Inadequate Nutrient Intake?: TUA Study (Kumpulan Penuaan yang Mana Lebih Cenderung Terhadap Pengambilan Nutrien yang tidak Mencukupi?: Kajian TUA)

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### ABSTRACT

*Older adults quite often had an inadequate diet leading to micronutrient deficiencies and impaired immune response with subsequent development of degenerative diseases. This study aimed to determine the adequacy of energy and nutrient intake and its distribution among three aging groups i.e. successful aging (SA), usual aging (UA) and mild cognitive impairment (MCI). This is a cross-sectional study involving a large sample size (n = 2322) of older adults recruited through multistage random sampling from four states of Malaysia. An interview was conducted to measure dietary intake, neurocognitive status and functional status by using the Diet History Questionnaire (DHQ), Mini-Mental State Examination (MMSE), Rey Auditory Learning Test (RAVLT), Geriatric Depression Scale (GDS), Instrumental Activity of Daily Living (IADL) and Quality of Life Questionnaire. For comparison of dietary intake, a sub-sample of 173 respondents from each aging groups were matched and selected using a comparative cross-sectional approach. Women in SA group had the highest mean intake of vitamin A, calcium (p <0.05), vitamin C, riboflavin and iron (p<0.001). The same aging group also achieved the highest RNI percentage for the same nutrients. More than 80% of respondents for all aging groups did not met the recommended nutrient intake (RNI) for vitamin E, thiamin, niacin, folate, calcium and zinc. In women, MCI respondents were more likely to have an inadequate intake of vitamin A, C, riboflavin and iron followed by UA and SA. Inadequate vitamin E, niacin, folate and calcium were prevalent among all gender and aging groups. There is a need to further distinguish specific dietary patterns associated with these three aging groups to promote optimal nutrient intake for cognitive health.*

**Keywords:** Elderly; mild cognitive impairment; nutrients intake; successful ageing; usual ageing

### ABSTRAK

*Warga tua seringkali mengambil diet yang tidak mencukupi yang membawa kepada masalah kekurangan nutrien serta menjejaskan tindak balas imun dan menjurus kepada berlakunya penyakit degeneratif. Kajian ini bertujuan untuk menentukan pengambilan tenaga dan nutrien serta pengagihannya dalam kalangan tiga kumpulan penuaan iaitu penuaan berjaya (SA), penuaan biasa (UA) dan kecelaan kognitif ringan (MCI). Kajian hirisan lintang ini melibatkan saiz sampel warga tua yang besar (n=2322) yang dipilih berdasarkan persampelan rawak pelbagai peringkat dari empat buah negeri di Malaysia. Temu bual telah dijalankan untuk mengukur pengambilan makanan, status neurokognitif serta status kefungsi dengan menggunakan Soal Selidik Sejarah Diet (DHQ), Pemeriksaan Keadaan Mental Mini (MMSE), Ujian Pembelajaran Lisan Pendengaran Rey (RAVLT), Skala Kekecewaan Geriatrik (GDS), Alatan Aktiviti Hidup Sehari-hari (IADL) dan Soal Selidik Kualiti Hidup. Bagi perbandingan antara kumpulan penuaan, sebanyak 173 sub sampel daripada setiap kumpulan telah dipadankan dan dipilih menggunakan pendekatan perbandingan hirisan lintang. Wanita dari kumpulan SA mempunyai min pengambilan vitamin A, kalsium (p<0.05), vitamin C, riboflavin dan zat besi (p<0.001) yang paling tinggi. Kumpulan penuaan yang sama juga mencapai peratusan Saranan Pengambilan Makanan (RNI) yang paling tinggi bagi nutrien tersebut. Lebih daripada 80% subjek untuk semua kumpulan penuaan tidak mencapai saranan bagi vitamin E, tiamin, niasin, folat, kalsium dan zink. Pengambilan vitamin A, C, riboflavin dan niasin yang tidak mencukupi lebih cenderung terjadi dalam kalangan wanita daripada kumpulan MCI, diikuti UA dan SA. Kesimpulannya, pengambilan vitamin E, niasin, folat dan kalsium yang tidak mencukupi lazim terjadi dalam kalangan semua jantina dan kumpulan penuaan. Oleh itu, terdapat keperluan dalam menentukan corak pemakanan yang lebih spesifik yang berkaitan dengan kumpulan penuaan tersebut bagi menggalakkan pengambilan nutrien yang optimum bagi kesihatan kognitif.*

**Kata kunci:** Kecelaan kognitif ringan; pengambilan nutrien; penuaan berjaya; penuaan biasa; warga tua

## INTRODUCTION

Studies focusing on health-related behaviors frequently examine how a particular health-related behavior, such as caloric intake or regularity of physical activity, associated with successful aging, such as longevity, subjective well-being, or physical health. Recently, in addition to antioxidants (Wong et al. 2010), vitamin B (Doets et al. 2013; Vogiatzoglou et al. 2013), omega-3 fatty acid (Solfrizzi et al. 2010, 2009) i.e. EPA and DHA (Van Gelder et al. 2007) and folate (Morris et al. 2005), nutrients including calcium, magnesium and potassium have also been associated with risk of cognitive decline (Cherbuin et al. 2014). Definition of Mild Cognitive Impairment (MCI) was derived by Mayo Clinic (Petersen et al. 1999) which includes self- or informant-reported memory complaint, objective memory complaint, essentially preserved general cognitive functioning, preserved independence in functional abilities and absence of dementia. MCI was detected among 21.1% of urban elderly from low to middle housing residential areas in Cheras, Selangor and were associated with hypercholesterolemia in men and married status, no exercise practice, overweight and obesity in women (Lee et al. 2012). In a study of more than 2000 older individuals in Malaysia, the prevalence of successful agers was 13.8%, particularly among those in younger age, Chinese and had a higher education level and income (Hamid et al. 2012). However, little is known about the association between dietary inadequacy with cognitive decline and successful aging. Dietary intake known to be implicated in biological processes associated with vascular and Alzheimer's pathology and may contribute to disease progression earlier in the disease process and require further attention. Since diet is highly modifiable and exerts its influence over the lifespan, it is imperative to have a better understanding on the association between SA, UA and MCI with energy and nutrient intake by which intervention are most likely to be effective. In this study, we have examined the data collected from a large population based sample ( $n=2322$ ), of which 193 respondents from each aging groups were matched and selected for comparative cross-sectional study of nutrient intake and its adequacy in relation to cognition and successful aging.

## MATERIALS AND METHODS

### STUDY DESIGN AND RESPONDENTS

This is a large population based cross-sectional study among 2322 individuals aged 60 years and above recruited from four states of Malaysia namely Kelantan, Selangor, Perak and Johor, recruited through multistage random sampling between May 2013 and February 2014. These states were selected on the basis of random sampling. Malaysian elderly i.e. Malay, Chinese, or Indian and others aged 60 years and above were included in the study. Exclusion criteria include bedridden, had psychiatric problem such as depression, dementia, mute and deaf.

There were 123 respondents who did not meet the criteria due to MMSE score of less than 14, thus indicating dementia (MOH 2009). Out of 2199 respondents, 2073 have completed Diet History Questionnaire and were included in this analysis. There were 13 subjects who were excluded due to incomplete neurocognitive test and they were not assigned in any group. Further comparative cross-sectional study was used to perform energy and dietary intake analysis according to three aging groups, namely SA, UA and MCI. Respondents in the three groups were matched for gender, age ( $\pm 10$  years) and ethnicity. A household visit was conducted to invite selected respondents to participate in health screening held at respective community centers, of which detail description of the methods has been published elsewhere (Shahar et al. 2015). The project was approved by the Research Ethics Committee of Universiti Kebangsaan Malaysia (UKM 1.5.3.5/244/NN-060-2013). Written informed consent to participate in the study was obtained from all respondents.

### SOCIO-DEMOGRAPHIC VARIABLES

A pre-tested questionnaire was used to obtain socio-demographic information which includes gender, ethnicity, religion, age, marital status, years of formal education, living status and smoking and alcohol intake through face to face interview.

### CLASSIFICATION OF SA, UA AND MCI

Respondents were classified according to particular aging groups according to study reported by Shahar et al. (2015).

### DIETARY ASSESSMENT

Respondents were interviewed face to face to obtain their usual intake of food and drinks within a week using a validated Diet History Questionnaire (Shahar et al. 2000). Probing technique was applied to obtain information on the types of food and drinks, method of preparation, ingredients and amount for each food items consumed by the respondents. The amount of food consumed was estimated using household measurements such as cups, spoons, glass, bowls and plates. In addition, food atlas (Suzana et al. 2015) was used to facilitate identification of foods consumed. Assistance from family members was obtained for respondents who were unable to recall exactly the amount of food consumed. At the end of the session, the interviewers review the entire questionnaire with the respondents in order to ensure accuracy of the data collected.

### DIETARY DATA ANALYSIS

Energy and nutrient composition of food consumed by each respondent was calculated using Nutritionist Pro Version 3.1.0 software. Foods that are not available in the software were computed manually according to standard recipes. Energy and nutrient content of these recipes were

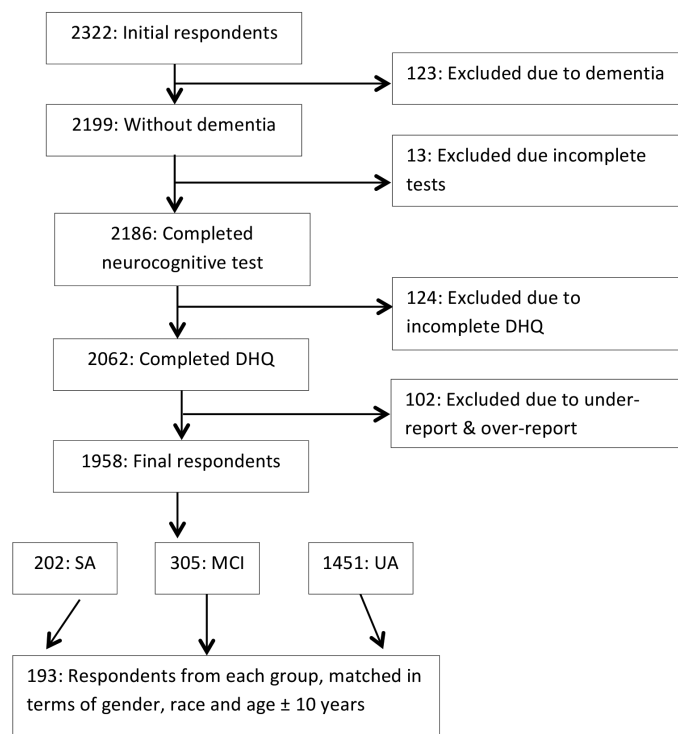


FIGURE 1. Flow chart of number of respondents in this study

TABLE 1. Socio-demographic characteristics of according to gender  
(Expressed means  $\pm$  SD and  $n$  (%))

Characteristics	Men ( $n=967$ )	Women ( $n=992$ )
Age (mean $\pm$ SD)	69.4 $\pm$ 6.0	68.2 $\pm$ 5.9 <sup>b</sup>
State, $n$ (%)		
Kelantan	377 (39.0)	226 (22.8)
Selangor	205 (21.2)	265 (26.7)
Perak	205 (21.2)	271 (27.3)
Johor	180 (18.6)	229 (23.1) <sup>a</sup>
Age group (years), $n$ (%)		
60 – 69	519 (53.7)	632 (63.8)
70-79	393 (40.5)	318 (32.1)
$\geq$ 80	55 (5.7)	41 (4.1) <sup>a</sup>
Marital status, $n$ (%)		
Married	862 (89.1)	513 (51.8)
Unmarried	105 (10.9)	478 (48.2)
Ethnicity, $n$ (%)		
Malay	638 (66.0)	592 (59.7)
Chinese	275 (28.4)	355 (35.8)
Indian & others	54 (5.6)	44 (4.4) <sup>b</sup>
Education, $n$ (%)		
No formal education	88 (9.1)	273 (27.5)
Primary	609 (63.0)	544 (54.9)
Secondary	236 (24.4)	164 (16.5)
Tertiary	34 (3.5)	10 (1.0) <sup>a</sup>
Aging group, $n$ (%)		
Successful aging	113 (11.1)	89 (9.0)
Mild Cognitive Impairment	167 (17.3)	138 (13.9)
Usual Aging	687 (71.0)	764 (77.1)

<sup>a</sup> ( $p<0.001$ ) and <sup>b</sup> ( $p<0.05$ ) show significant different with Chi Square test

analysed using the Malaysian Food Composition Tables (Tee et al. 1997) and the values were entered into the Nutritionist Pro software.

#### EVALUATION OF UNDER AND OVER-REPORTING

Respondents with reported energy intake below 2.5th percentile and 97.5th percentile were used to examine the prevalence of under and over-reporting (Konstantinova et al. 2008). Out of 2060, 102 respondents who were under and over reports were excluded from further analyses. Therefore, 1958 respondents were included in overall dietary analysis and 579 respondents for dietary analysis according to age groups (Figure 1).

#### DIETARY ADEQUACY

The results obtained from the dietary analyses were then compared to the Recommended Nutrient Intakes (RNIs) for Malaysians (NCCFN 2005) to determine dietary adequacy.

#### STATISTICAL ANALYSIS

All statistical analyses were performed using SPSS version 22.0 for Windows (SPSS Inc.). Data from Nutritionist Pro were transferred to SPSS. The nutrient intake distributions were presented in mean  $\pm$  SD to characterize population intake levels for gender. One-way ANOVA was tested to observe the significant mean difference according to age groups. Descriptive data were showed in percentage and Chi Square Test.

#### RESULTS

A total of 1958 respondents were included in the present analysis. As shown in Table 1, this study involved 50.6% women and 49.4% men, with men were significantly older than women ( $p < 0.001$ ). As expected, majority of the respondents were Malays, from Kelantan, with age ranged from 60 to 69 years old. In terms of marital status, majority of men were married. A total of 63.0% of men and 54.9% of women had primary education ( $p < 0.001$ ). In further subsample comparative cross-sectional analysis according to three aging groups, men from SA group were the youngest, followed by UA and MCI. Among women respondents, there was a significant difference in mean age between UA and MCI respondents, i.e.  $69.1 \pm 5.4$  and  $67.7 \pm 5.2$  years old, respectively ( $p < 0.001$ ). Both MCI men and women respondents had lower education years compared to UA respondents. There were 11 men and 2 women respondents in neither of the group in which their data to evaluate for aging groups were incomplete.

Table 2 shows that energy intake of men ( $1770 \pm 423$  kcal/day) were significantly higher than women ( $1536 \pm 369$  kcal/day) ( $p < 0.05$ ). The energy intake for both gender did not meet recommendations. In our study, there were 2.4% and 2.5% respondents with under and over-reporting of energy intake, respectively. Mean intake for protein, carbohydrate, fat, niacin, iron and zinc was also

significantly higher in men as compared to women ( $p < 0.001$  for all parameters except niacin  $p < 0.05$ ). However, vitamin E intake in women ( $15.1 \pm 72.6$  mg/day) was significantly higher as compared to men ( $7.2 \pm 37.4$  mg/d) ( $p < 0.05$ ). Women respondents achieved higher percentage of protein, vitamin E, riboflavin, niacin, iron, zinc and selenium than men ( $p < 0.001$  for all parameters). Most of the respondents met the recommendation for protein, especially women. Because of that, protein composition among women subject was higher than men subject which is  $17.6 \pm 3.4\%$ . Men respondents show higher composition of carbohydrate but lower composition in fat percentage. All respondents in this study meet recommendation for macronutrients. As shown in Figure 2, more than 80% of the respondents did not meet the recommendations for vitamin E, niacin, folate and calcium in both genders. Men did not met the recommendations for vitamin A, E, niacin, folate, iron and zinc as compared to women ( $p < 0.001$  for all parameters except  $p < 0.05$  for vitamin A).

Table 3 shows no significant difference in energy and nutrients intake between all age groups among men. Men successful agers had highest carbohydrate composition per energy intake but lowest protein composition per energy intake as compared to UA respondents. In Table 4, women respondents with MCI had the lowest mean intake of vitamin A;  $1127.5 \pm 908.1$  RE/d, vitamin C;  $91.5 \pm 63.0$  mg/d, vitamin E;  $4.1 \pm 2.1$  mg/d, riboflavin;  $1.0 \pm 0.4$  mg/d, calcium;  $452.6 \pm 218.9$  mg/d, iron;  $11.8 \pm 5.1$  mg/d and zinc;  $2.9 \pm 1.4$  mg/d, as compared to UA and SA ( $p < 0.05$  for all parameters except  $p < 0.001$  for riboflavin). This study showed that calcium intake was the highest among women SA as compared to UA and MCI. Adequacy of the diet examined with reference to the RNI (NCCFN 2005) shows a significantly higher percentage of SA respondents who met the recommendations for vitamin A, C, D, riboflavin, calcium and iron. Protein compositions per energy intake of women UA respondents were higher as compared to SA respondents. As shown in Figure 3, inadequate vitamin D intake was common among SA men respondents. However, in women, more than 80% of the respondents did not meet recommendation for vitamin E, thiamine, niacin, folate and calcium (Figure 4). The higher percentage of inadequate vitamin A, C, riboflavin and iron intake was observed among women in MCI group followed by UA and SA respondents ( $p < 0.05$  for all parameters).

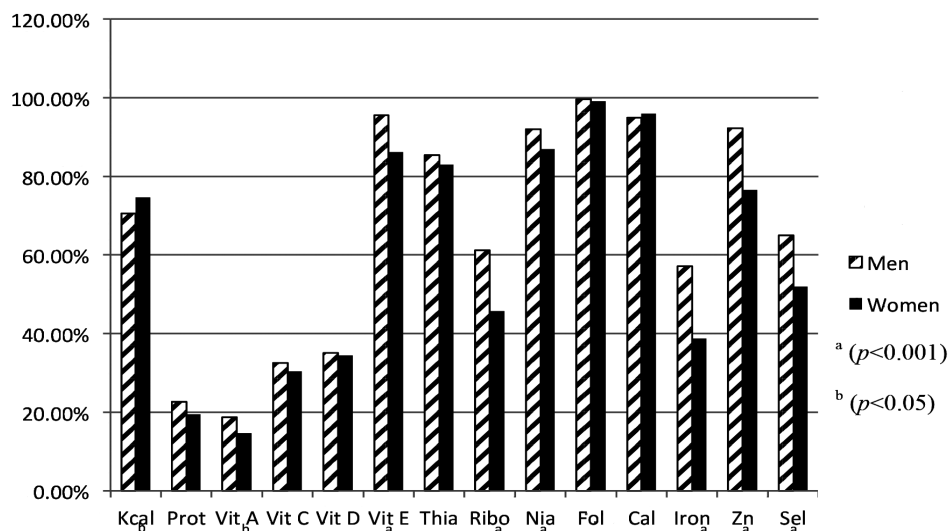
#### DISCUSSION

Energy intake for both men and women respondents did not meet the recommendation. Similarly, Iranagh et al. (2014) have reported that energy intakes among 432 older urban and rural Iranian adults were lower than the Recommended Dietary Allowance (RDA). Low energy intake could be due to under reporting, however, in our study, under-reporting and over-reporting energy intake were excluded from analysis to avoid inaccuracy of data analysis and may complicate data interpretation as well. Meng et al. (2013) studied under-reporting energy intake

TABLE 2. Energy and nutrients intake for all respondents according to gender (expressed as mean  $\pm$  SD)

Nutrients	Men (n = 978)	RNI	% RNI	Women (n = 993)	RNI	% RNI
Energy (kcal/d)	1770 $\pm$ 423	2010	88.1 $\pm$ 21.1	1537 $\pm$ 370 <sup>a</sup>	1780	86.3 $\pm$ 20.8
Protein (g/d)	73.8 $\pm$ 19.6	59.0	125.1 $\pm$ 33.3	67.5 $\pm$ 20.0 <sup>a</sup>	51.0	132.4 $\pm$ 39.2 <sup>a</sup>
Carbohydrate (g/d)	245.7 $\pm$ 71.8	-	-	202.2 $\pm$ 58.0 <sup>a</sup>	-	-
Fat (g/d)	54.7 $\pm$ 20.3	-	-	50.8 $\pm$ 17.8 <sup>a</sup>	-	-
Vit A (RE/d)	1228.5 $\pm$ 841.2	600.0	204.8 $\pm$ 140.3	1196.9 $\pm$ 798.2	500.0 – 600.0	215.2 $\pm$ 144.5
Vit C (mg/d)	113.4 $\pm$ 79.1	70.0	162.0 $\pm$ 113.0	118.8 $\pm$ 83.7	70.0	169.8 $\pm$ 119.6
Vit D (mg/d)	0.3 $\pm$ 2.9	10.0-15.0	2.5 $\pm$ 19.5	0.3 $\pm$ 1.1	10.0 – 15.0	2.6 $\pm$ 9.1
Vit E (mg/d)	7.2 $\pm$ 37.4	10.0	71.9 $\pm$ 374.5	15.2 $\pm$ 72.6 <sup>b</sup>	7.5	202.0 $\pm$ 968.5 <sup>a</sup>
Thiamin (mg/d)	1.6 $\pm$ 3.8	1.2	133.3 $\pm$ 318.0	1.5 $\pm$ 3.5	1.1	136.4 $\pm$ 314.3
Riboflavin (mg/d)	1.2 $\pm$ 0.5	1.3	95.4 $\pm$ 35.3	1.2 $\pm$ 0.5	1.1	110.6 $\pm$ 45.5 <sup>a</sup>
Niacin (mg/d)	10.6 $\pm$ 3.8	16.0	66.4 $\pm$ 23.7	10.1 $\pm$ 3.8 <sup>b</sup>	14.0	72.3 $\pm$ 27.3 <sup>a</sup>
Folate (mg/d)	105.3 $\pm$ 70.5	400.0	26.3 $\pm$ 17.6	107.5 $\pm$ 79.8	400.0	26.9 $\pm$ 19.9
Calcium (mg/d)	527.4 $\pm$ 237.8	800.0-1000.0	56.4 $\pm$ 25.6	511.2 $\pm$ 245.4	1000.0	51.1 $\pm$ 24.5 <sup>a</sup>
Iron (mg/d)	14.0 $\pm$ 5.1	14.0	99.8 $\pm$ 36.7	13.1 $\pm$ 5.2 <sup>a</sup>	11.0	119.1 $\pm$ 47.1 <sup>a</sup>
Zinc (mg/d)	3.8 $\pm$ 2.0	6.2 – 6.7	60.0 $\pm$ 31.2	3.4 $\pm$ 1.8 <sup>a</sup>	4.3 – 4.9	75.8 $\pm$ 39.6 <sup>a</sup>
Selenium (mg/d)	23.9 $\pm$ 18.9	29 – 33	79.6 $\pm$ 63.5	24.1 $\pm$ 17.5	23.0 – 25.0	101.3 $\pm$ 74.0 <sup>a</sup>
CHO composition (%)	55.3 $\pm$ 7.8			52.7 $\pm$ 8.1 <sup>a</sup>		
Protein composition (%)	16.9 $\pm$ 3.3			17.6 $\pm$ 3.4 <sup>a</sup>		
Fat composition (%)	27.8 $\pm$ 7.2			29.6 $\pm$ 7.0 <sup>a</sup>		

<sup>a</sup> ( $p < 0.001$ ) and <sup>b</sup> ( $p < 0.05$ ) show significant different with independent t-test



<sup>a</sup> ( $p < 0.001$ ) and <sup>b</sup> ( $p < 0.05$ ) show significant different with Chi Square test ( $n=1958$ )

FIGURE 2. Percentage of respondents did not met RNI according to gender

among Australian women and found that under-reporters perform higher physical activity level, body weight, body mass index, waist and hip circumference, whole body fat mass and percentage body fat compared with acceptable-reporters. In addition, they found that under-reporters had lower intake of protein, fat, carbohydrate and alcohol and fewer reported items as compared to acceptable-reporter. Women respondents had higher intakes and achieved higher percentage of vitamin E compared to men and as mentioned by Hui et al. (2012), women with calcium intake less than 300 mg/day and protein intake less than 1 g/kg body weight have higher risk to fall down. In comparison of aging groups among women, MCI respondents had the lowest intake of vitamin E. Vitamin E is well known for its potent antioxidant activity. This vitamin is a fat-soluble vitamin which gives benefit and maintains cognitive function in elderly (Devore et al. 2013; Kang & Grodstein 2008; Wengreen et al. 2007). The Cache County Study on memory and aging reported that respondents who consumed vitamin E at the highest quartile of intake showed slower cognitive decline, measured by the modified MMSE, than those in the first and second quartiles, with the intake of approximately 4.6 and 6.1 mg/day, respectively (Wengreen et al. 2007). Besides that, protein intake among respondents in this study met the recommendation especially in women, probably due to consumption of rice which is a good source of carbohydrates and protein that providing energy. Commercial rice from three rice varieties namely Basmati, Fragrant and Siam are the most consumed by Malaysians (Fairulnizal et al. 2015). Protein content in Fragrant, Basmati and Siam rice were  $7.17 \pm 0.35$ ,  $8.35 \pm 0.2$  and  $7.55 \pm 0.32$  g/100 g, respectively. There is a need to investigate further on the quality of protein being consumed. Inadequate intake of iron is prone among

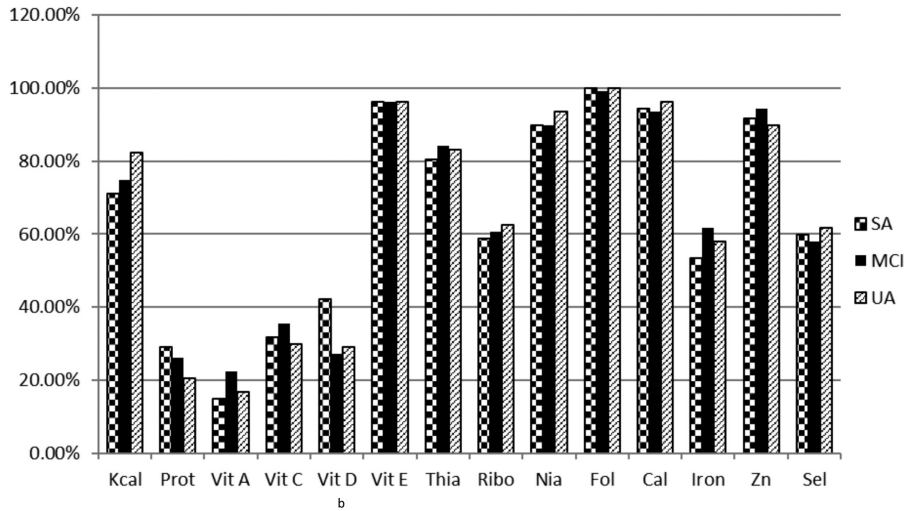
men respondents, as compared to women often due to multifactorial factors including medication, inadequate dietary intake, malabsorption and bleeding (Busti et al. 2014). These conditions can lead to anemia which can affect the quality of life of older adults. According to a study by Aris et al. (2009) and Corona et al. (2014), prevalence of anemia in older adults was 22.9% and 7.7%, respectively. They suggested it was associated with the presence of chronic disease and advanced age.

The risk of MCI and dementia increased among individuals with high caloric intake from carbohydrates and low caloric intake from fat and protein (Roberts et al. 2012). On a contrary, long term intake of diet high in complex carbohydrate such as fruits, legumes, vegetables and cereals can potentially promote better cognition compared to simple carbohydrate that has an immediate effect on cognitive function (Dai et al. 2006; Gu et al. 2010; Hughes et al. 2010; Kang et al. 2005; Morris et al. 2006). Our finding showed that men successful agers had the highest caloric intake from carbohydrates but the lowest caloric intake from protein. In addition, consumption of dairy products at least once per day was associated with an improvement in several measures of cognitive function (Crichton et al. 2012). This finding was similar to our results that indicated women in SA group had highest intake of calcium as compared to other groups. Moreover, more of SA respondents met recommendation of calcium. Rahman et al. (2007) reported nutrients found in milk products, possibly vitamin A and/or individual dairy fat can potentially responsible for the positive association. Holton et al. (2012) examined the relation between micronutrients intake and cognitive function in elderly men and they found that dietary intake above the RDA for B3, B12, iron & zinc combined, may promote cognitive function in elderly men.

TABLE 3. Energy and nutrients intake for men respondents according to ageing groups (expressed as mean  $\pm$  SD)

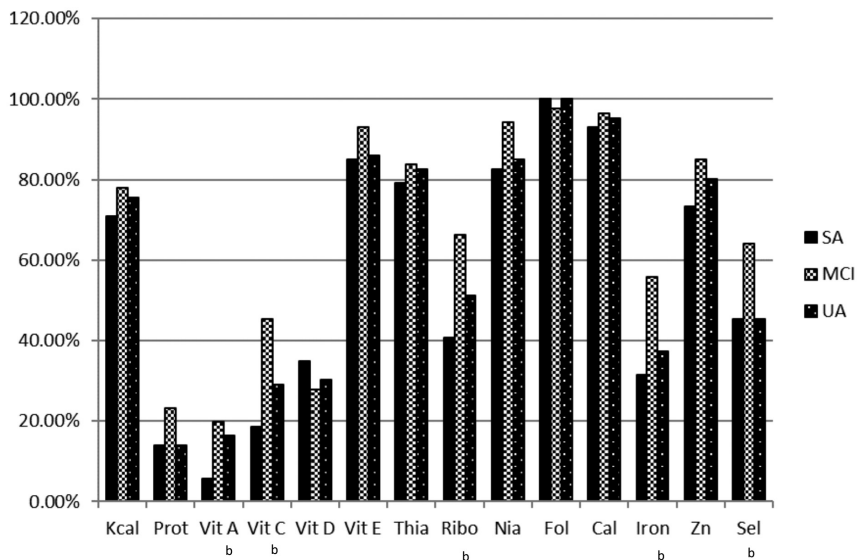
Characteristics	SA (n = 107)	MCI (n = 107)	UA (n = 107)				
Age	68.0 $\pm$ 5.6 <sup>a</sup>	69.4 $\pm$ 5.4 <sup>b</sup>	69.3 $\pm$ 5.1 <sup>a</sup>				
Education years	8.1 $\pm$ 4.2	5.5 $\pm$ 3.1 <sup>a</sup>	5.8 $\pm$ 3.5 <sup>a</sup>				
Nutrients	RNI	% RNI	% RNI				
Energy (kcal/d)	2010	1751 $\pm$ 452	87.1 $\pm$ 22.5	1722 $\pm$ 412	85.7 $\pm$ 20.5	1737 $\pm$ 390	86.4 $\pm$ 20.8
Protein (g/d)	59.0	69.6 $\pm$ 21.0	118.0 $\pm$ 35.5	71.7 $\pm$ 19.0	121.6 $\pm$ 32.2	75.2 $\pm$ 18.7	127.5 $\pm$ 31.7
CHO (g/d)	-	251.3 $\pm$ 76.1	-	238.1 $\pm$ 68.8	-	237.8 $\pm$ 63.8	-
Fat (g/d)	-	51.8 $\pm$ 17.8	-	52.8 $\pm$ 17.8	-	53.9 $\pm$ 17.1	-
Vit A (RE/d)	600.0	1224.5 $\pm$ 789.4	204.1 $\pm$ 131.6	1235.6 $\pm$ 938.3	205.9 $\pm$ 156.4	1219.7 $\pm$ 762.5	203.2 $\pm$ 127.1
Vit C (mg/d)	70.0	112.3 $\pm$ 72.8	160.5 $\pm$ 103.9	63.2 $\pm$ 6.1	146.5 $\pm$ 90.3	112.0 $\pm$ 72.5	160.0 $\pm$ 103.6
Vit D (mg/d)	10.0-15.0	0.3 $\pm$ 0.6	2.2 $\pm$ 4.5	0.3 $\pm$ 1.1	2.3 $\pm$ 7.7	0.2 $\pm$ 0.8	1.7 $\pm$ 5.5
Vit E (mg/d)	10.0	4.6 $\pm$ 2.7	45.5 $\pm$ 27.1	4.5 $\pm$ 2.6	26.4 $\pm$ 2.6	4.7 $\pm$ 2.3	47.3 $\pm$ 23.3
Thiamin (mg/d)	1.2	2.4 $\pm$ 5.9	202.8 $\pm$ 492.0	2.1 $\pm$ 5.0	176.3 $\pm$ 419.6	2.4 $\pm$ 5.7	201.4 $\pm$ 479.0
Riboflavin (mg/d)	1.3	1.3 $\pm$ 0.5	100.7 $\pm$ 39.2	1.2 $\pm$ 0.5	93.1 $\pm$ 35.6	1.2 $\pm$ 0.4	91.4 $\pm$ 28.0
Niacin (mg/d)	16.0	10.7 $\pm$ 4.5	67.2 $\pm$ 28.4	10.2 $\pm$ 3.7	63.7 $\pm$ 23.2	10.7 $\pm$ 3.3	66.8 $\pm$ 20.7
Folate (mg/d)	400.0	110.7 $\pm$ 66.0	27.7 $\pm$ 15.5	98.3 $\pm$ 80.2	24.6 $\pm$ 20.1	98.6 $\pm$ 61.7	24.6 $\pm$ 15.4
Calcium (mg/d)	800.0-1000.0	526.8 $\pm$ 215.1	57.4 $\pm$ 23.7	523.0 $\pm$ 282.4	55.9 $\pm$ 28.7	512.5 $\pm$ 186.9	54.7 $\pm$ 21.2
Iron (mg/d)	14.0	13.7 $\pm$ 5.0	97.8 $\pm$ 35.5	13.6 $\pm$ 5.9	97.1 $\pm$ 42.1	13.6 $\pm$ 4.6	97.0 $\pm$ 32.5
Zink (mg/d)	6.2 - 6.7	3.7 $\pm$ 2.1	57.2 $\pm$ 32.1	3.5 $\pm$ 1.7	55.2 $\pm$ 26.4	3.9 $\pm$ 1.8	62.2 $\pm$ 28.7
Selenium (mg/d)	29 - 33	28.1 $\pm$ 22.9	92.7 $\pm$ 76.2	23.5 $\pm$ 18.8	78.5 $\pm$ 633.7	23.4 $\pm$ 18.4	78.7 $\pm$ 62.8
CHO composition (%)		57.2 $\pm$ 7.4 <sup>b</sup>		55.2 $\pm$ 7.7		54.7 $\pm$ 7.3 <sup>b</sup>	
Protein composition (%)		16.0 $\pm$ 3.3 <sup>b</sup>		16.9 $\pm$ 3.1		17.5 $\pm$ 3.1 <sup>b</sup>	
Fat composition (%)		26.6 $\pm$ 6.0		27.6 $\pm$ 6.4		27.9 $\pm$ 6.6	

<sup>a</sup> (p<0.001) and <sup>b</sup> (p<0.05) show significant different with One-way ANOVA test



<sup>b</sup> ( $p < 0.05$ ) shows significant different with Chi Square test ( $n = 321$ )

FIGURE 3. Percentage of men respondents did not met RNI according to ageing groups (comparative cross-sectional)



<sup>b</sup> ( $p < 0.05$ ) show significant different with Chi-Square test ( $n = 258$ )

FIGURE 4. Percentage of women respondents did not met RNI according to ageing groups (comparative cross-sectional)

STRENGTHS AND LIMITATIONS

To the best of our knowledge, there is no study done before in Malaysia that highlighted nutrient intakes according to the three aging groups. Moreover, this is a large study ( $n = 2322$ ) which represents sample of Malaysian older adults population from wide range of socio-demographic backgrounds. Nevertheless, please bear in mind that the food composition database of Malaysian food is rather incomplete of selected nutrients including vitamin D, E and folate, that would results in under or overestimation of these nutrients. We propose

an in depth investigation on food intake of elderly using dietary pattern methods in order to provide more objective information on habitual dietary intake. By using posteriori dietary patterns, some key ingredients and food groups that are associated consistently with aging groups can be identified. Nevertheless, findings in this study can be used as a baseline for dietary pattern analysis and furthermore for identification of particular metabolite that may exists in each aging groups to prevent or delay adverse cognitive outcomes.



TABLE 4. Energy and nutrients intake for women respondents according to ageing groups (expressed as mean  $\pm$  SD)

Characteristics	SA (n = 86)	MCI (n = 86)	UA (n = 86)
Age	65.3 $\pm$ 5.2	67.7 $\pm$ 5.2 <sup>a</sup>	69.1 $\pm$ 5.4 <sup>a</sup>
Education years	7.6 $\pm$ 4.3	3.4 $\pm$ 3.0 <sup>a</sup>	3.2 $\pm$ 3.4 <sup>a</sup>
Nutrients			
CHO (g/d)	210.5 $\pm$ 56.0	196.7 $\pm$ 60.9	200.4 $\pm$ 49.6
Fat (g/d)	52.8 $\pm$ 20.0	49.3 $\pm$ 19.0	50.9 $\pm$ 18.0
Vit A (RE/d)	500.0 – 600.0	1127.5 $\pm$ 908.1 <sup>b</sup>	1216.4 $\pm$ 828.3
Vit C (mg/d)	70.0	91.5 $\pm$ 63.0 <sup>a</sup>	120.3 $\pm$ 84.0 <sup>a</sup>
Vit D (mg/d)	10.0 – 15.0	0.3	0.6
Vit E (mg/d)	7.5	4.1 $\pm$ 2.1 <sup>b</sup>	31.4 $\pm$ 118.1 <sup>b</sup>
Thiamin (mg/d)	1.1	1.6 $\pm$ 3.6	1.4 $\pm$ 2.8
Riboflavin (mg/d)	1.1	0.4 <sup>a</sup>	1.2 $\pm$ 0.5
Niacin (mg/d)	14.0	9.3 $\pm$ 3.2	10.5 $\pm$ 3.5
Folate (mg/d)	400.0	88.8 $\pm$ 84.1	116.9 $\pm$ 80.8
Calcium (mg/d)	1000.0	452.6 $\pm$ 218.9 <sup>b</sup>	523.7 $\pm$ 216.3
Iron (mg/d)	11.0	11.8 $\pm$ 5.1 <sup>b</sup>	13.2 $\pm$ 5.0
Zink (mg/d)	4.3 – 4.9	2.9 $\pm$ 1.4 <sup>b</sup>	3.4 $\pm$ 1.5
Selenium (mg/d)	23.0 – 25.0	22.3 $\pm$ 19.2	27.6 $\pm$ 18.4
Protein intake (g/kg)		1.1 $\pm$ 0.4	1.2 $\pm$ 0.4
CHO composition (%)		52.6 $\pm$ 9.0	1.2 $\pm$ 0.4
Protein composition (%)		17.7 $\pm$ 3.0	18.1 $\pm$ 3.5 <sup>b</sup>
Fat composition (%)		29.6 $\pm$ 7.2	29.4 $\pm$ 6.1

<sup>a</sup> ( $p < 0.001$ ) and <sup>b</sup> ( $p < 0.05$ ) show significant different with One-way ANOVA test

## CONCLUSION

This study found that the diet of respondents did not meet the recommendation for energy and selected micronutrients, particularly vitamin A and iron. Men were found to be at a higher risk of nutrient inadequacy, particularly for vitamin A, E, niacin, ferum and zinc. SA men tend to have adequate intake of vitamin D than in women. MCI respondents prone to have inadequate intake of vitamin A, C, riboflavin and iron. Overall, vitamin E, niacin, folate and calcium were the nutrients most likely to be inadequate in the diet of older adults in this study. Further analysis of dietary pattern according to each aging groups should be carried out in order to provide more meaningful information leading to food based dietary guidelines for healthy longevity.

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