# B VITAMINS INTAKE AND COGNITIVE STATUS AMONG ELDERLY IN AGRICULTURAL SETTLEMENTS

NUR FATIN ATIQAH LOKMAN, BSc (HONS)
DEPARTMENT OF NUTRITION SCIENCES, KULLIYYAH OF ALLIED HEALTH SCIENCES, INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA, JALAN SULTAN AHMAD SHAH, BANDAR INDERA MAHKOTA, 25200 KUANTAN, PAHANG, MALAYSIA
fatinatiqah854@hotmail.com

ALIZA HASLINDA HAMIRUDIN, PhD (CORRESPONDING AUTHOR)
DEPARTMENT OF NUTRITION SCIENCES, KULLIYYAH OF ALLIED HEALTH SCIENCES, INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA, JALAN SULTAN AHMAD SHAH, BANDAR INDERA MAHKOTA, 25200 KUANTAN, PAHANG, MALAYSIA
aliza@iium.edu.my

SURIATI SIDEK, PhD
DEPARTMENT OF PSYCHOLOGY, KULLIYYAH OF ISLAMIC REVEALED KNOWLEDGE AND HUMAN SCIENCES, INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA, JALAN GOMBAK, 53100 KUALA LUMPUR, MALAYSIA
suriatisidek@iium.edu.my

NORAIN ZAINUDIN, BSc (HONS)
DEPARTMENT OF NUTRITION SCIENCES, KULLIYYAH OF ALLIED HEALTH SCIENCES, INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA, JALAN SULTAN AHMAD SHAH, BANDAR INDERA MAHKOTA, 25200 KUANTAN, PAHANG, MALAYSIA
norainzainudin91@gmail.com

NOR AZLINA A. RAHMAN, Master of Community Medicine
DEPARTMENT OF PHYSICAL REHABILITATION SCIENCES, KULLIYYAH OF ALLIED HEALTH SCIENCES, INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA, JALAN SULTAN AHMAD SHAH, BANDAR INDERA MAHKOTA, 25200 KUANTAN, PAHANG, MALAYSIA
nazara@iium.edu.my

## ABSTRACT

**Introduction:** The number of elderly who have been diagnosed with cognitive impairment are increasing in Malaysia and becoming a matter of a great concern for the health sectors. One of the ways to overcome this rising problem is by identifying one of its risk factors which is inadequate dietary intake particularly B vitamins (folate, vitamin $B_{12}$ and $B_6$). This study aimed to identify total B vitamins intake and its association with cognitive status of the elderly in agricultural settlements (FELDA) in Kuantan, Pahang. **Methods:** Seventy-eight elderly aged ≥60 years old were recruited in this study using convenience sampling. A home visit was done and subjects were interviewed using a questionnaire on their demographic data. Dietary history method was used to collect information on dietary intake; whilst the cognitive status was assessed using the Malay version of Mini Mental State Examination (MMSE). Dietary intake was analyzed using Nutritionist Pro Software version 3.00. The total B vitamins intake data were then compared with Recommended Nutrient Intakes for Malaysia (RNI 2017). **Results:** Majority of the subjects have inadequate total folate (93.6%), vitamin $B_6$ (92%) and

vitamin $B_{12}$ (63%) intake. The comparison between total B vitamins intake and RNI showed significant differences ($p$ = 0.001) except for vitamin $B_{12}$ ($p$= 0.398). Most of the subjects have normal cognitive function as 62.8% of them achieved normal MMSE score (≥24 out of 30 marks). No significant association between B vitamins intake and cognitive status of the elderly subjects were identified. **Conclusions:** High prevalence of inadequate B vitamins intake is evident among elderly living in agricultural settlements. Hence, a well-structured nutrition education programme and activities need to be conducted to ensure optimum nutritional and cognitive status among the elderly.

**KEYWORDS:** B vitamins intake, Cognitive Status, Elderly, Recommended Nutrient Intakes, Mini Mental State Examination (MMSE)

## INTRODUCTION

Elderly population around the globe is increasing annually due to advancement in healthcare services. This phenomenon has also been observed in Malaysia, in which an approximately 2.1 millions of Malaysian population is comprising of senior citizens in the year 2018, an increase of 2% from 2017 (Department of Statistics Malaysia, 2018). This increment requires greater attention from the government and healthcare providers as the demand for healthcare treatment and services will be substantial in elderly population due to multiple illnesses.

Dementia is now becoming a serious health problem among elderly (Nikmat, Hawthorne & Al-Mashoor, 2011; Fishman, 2017) in which it eventually increasing the financial costs not only for the caregivers; but also for the government as appropriate treatments are needed for dementia patients (Agarwal, 2011). The prevalence of people who have dementia in Malaysia is estimated to be about 50 000 (Alzheimer's Disease Foundation Malaysia, 2016). It has also been publicized that this figure will increase to 0.126% and 0.454% in 2020 and 2050, respectively (Nikmat et al., 2011). Thus, it is highly recommended for the community to preserve the cognitive ability in old age to promote healthy ageing and subsequently reduce healthcare expenditure.

There are few factors that are commonly associated with cognitive decline such as depression, aging, low level of education and also lifestyle factors particularly, nutritional deficiencies (Reay, Smith & Riby, 2013). It is notable that low B vitamins (folate, vitamin $B_6$ and vitamin $B_{12}$) intake may contribute to a decline in cognitive function (Kim, Kim, Jang, Kim, & Chang, 2014; O'Leary, Allman-Farinelli & Samman, 2012). The association between B vitamins (folate, vitamin $B_6$ and vitamin $B_{12}$) intake and cognitive function among the elderly has been extensively documented in previous studies. In a study conducted by Morris (2007), folate and vitamin $B_{12}$ deficiencies resulted in cognitive decline especially among the elderly aged 60 years old and above. Morris further explained that folate may help to reduce blood levels of the amino acid homocysteine (Hcy) which eventually help to slow cognitive decline associated with aging.

In addition, previous studies found that inadequate vitamin $B_6$ is associated with Alzheimer's disease, a disease resulted from cognitive impairment (Mulder et al., 2005; Skully, 2014). Vitamin $B_6$ exerts a wide range of functions in the human body and deficiency has been associated with cancer, cardiovascular events, seizures, migraine, chronic pain, depression, immune deficiency and most of all, it is associated with cognitive impairment (Skully, 2014). It can be abundantly found in food such as meat, poultry, liver, whole grains and banana.

However, there are limited studies on B vitamins (folate, vitamin $B_{12}$ and vitamin $B_6$) intake being conducted among elderly in Malaysia (Suzana, Boon, Chan & Normah, 2013). The available data in Malaysia showed that about 30% of Chinese elderly people from five old folk homes in Klang Valley have inadequate folate intake (serum folate < 7 mmol/l). As the previous findings have suggested that B vitamins play vital role in the efforts of delaying the onset of cognitive decline, this study thus, aimed to investigate B vitamins intake and its association with cognitive status among elderly living in agricultural settlements in Kuantan, Pahang.

## METHODS

### Participants of the Study

A cross-sectional study was conducted among seventy-eight elderly aged 60 years old and above from two agricultural settlements in Kuantan, Pahang which include Felda Bukit Goh and Felda Bukit Kuantan. Elderly who are Malaysian citizens and are able to communicate either in Malay or English were included in the study. However, elderly who are terminally ill, bedridden, on dialysis or on tube feeding were excluded from the study. All eligible subjects were invited to participate in the study and home visits have been done. Approval to conduct the study has been obtained from the Research Ethics Committee of International Islamic University Malaysia (IIUM/504/14/11/2/IREC 618). In addition, informed consent was also obtained from all subjects of the study prior to data collection.

### Assessment for B Vitamins Intake

A diet history method was used in order to assess the elderly persons' B vitamins intake. Questions related to usual meal pattern, type of food and beverages, portion size and frequency of intake were asked during the one-to-one interview session. B vitamins intake (folate, vitamin $B_{12}$, and vitamin $B_6$) were determined using the Nutritionist Pro Software version 3.00. Dietary intake of folate, vitamin $B_6$ and $B_{12}$ were compared with Recommended Nutrient Intakes for Malaysia (RNI 2017).

### Assessment for Cognitive Status

The Malay version of Mini Mental State Examination (MMSE) was used to assess the cognitive status of the subjects. It was conducted after the completion of diet history. The MMSE begins with a graded assessment of orientation to place and time, which the maximum point is 10 for this section. This is followed by testing the subject with two aspects of memory. The first is the immediate recall for three objects presented orally by the researcher, followed by a serial seven tasks which intervene to assess subject's attention, concentration, and spelling skills. All of these were done to prevent the subjects from rehearsing the three objects previously mentioned. A maximum of 11 points may be obtained in this section of the test. The final section of this survey is the testing functions of naming, repetition, understanding a three-stage command, reading, writing and copying a drawing. For this final section, there is a maximum of 9 points which can be obtained by the subjects. Out of a maximum score of 30, subjects were classified into three stages of cognitive status which are no cognitive impairment (≥24), mild cognitive impairment (18-23) and severe cognitive impairment (0-17).

### Statistical analysis

Data analysis was performed using Statistical Package for Social Sciences (SPSS) version 12.0. Sociodemographic data, B vitamins (folate, vitamin $B_6$ and vitamin $B_{12}$) intake and MMSE scores were analyzed by using descriptive statistics. All data were checked for normality prior to analysis. The

comparison of numerical outcome variables of total B vitamins (folate, vitamin $B_6$ and $B_{12}$) intake was evaluated by one sample t-test. Pearson correlation was used to test the association between B vitamins intake and cognitive status. Statistically significant value was set as $p<0.05$.

## RESULTS

### Socio-demographic Characteristics of the Subjects

Seventy-eight subjects participated in this study. The socio-demographic data of the subjects are presented in Table 1. The subjects comprised of 31 (39.7%) males and 47 (60.3%) females. 85.9% of the participants were married and only 14.1% were widowers. 14.1% of the subjects were living with their spouse; while 60.3% were living with spouse and children. 66.7% have household income less than RM1000 a month. On the other hand, 56.4% of the subjects obtained primary education as their highest educational status whereas only 11.5% of them achieved secondary education. The remaining of the elderly (32.1%) did not obtain formal education. For the smoking status, it was found that 82.1% of the subjects were non-smokers.

**Table 1** Socio-demographic characteristics of the elderly subjects (n = 78)

| Variables | Frequency (n = 78) | Percentage (%) |
|---|---|---|
| **Gender** | | |
| - Male | 31 | 39.7 |
| - Female | 47 | 60.3 |
| **Marital Status** | | |
| - Married | 67 | 85.9 |
| - Widower | 11 | 14.1 |
| **Living Status** | | |
| - With spouse | 11 | 14.1 |
| - With spouse and children | 47 | 60.3 |
| - With children | 20 | 25.6 |
| **Household Income** | | |
| - <1000 | 52 | 66.7 |
| - 1000-2000 | 22 | 28.2 |
| - >3000 | 4 | 5.1 |
| **Highest educational status** | | |
| - None | 25 | 32.1 |
| - Primary education | 44 | 56.4 |
| - Secondary education | 9 | 11.5 |
| - Tertiary education | 0 | 0 |
| **Smoking Status** | | |
| - Smoker | 3 | 3.8 |
| - Ex-smoker | 11 | 14.1 |
| - Non-smoker | 64 | 82.1 |

**Comparison of Total B Vitamins (Folate, Vitamin $B_6$ and Vitamin $B_{12}$) Intake with RNI**

According to RNI, folate requirement for male and female elderly aged 60 years old and above is 400 mcg/day. Table 2 shows that there was a significant difference between total folate intake and RNI for total folate among elderly ($p$ = 0.001). The mean folate intake of all elderly subjects was 165.46± 94.30 mcg/day and it was 58.63% lower than the 400 mcg of recommended folate intake.

**Table 2** Comparison of total folate intake of elderly subject with RNI

| Folate Requirement / Intake | | | |
|---|---|---|---|
| **RNI (mcg/day)** | **Mean (±SD) of Folate Intake (mcg/day)** | **% difference from RNI** | ***p*-value** |
| 400 | 165.46 (94.30) | -58.63 | 0.001* |

*$p$-value < 0.05

The finding suggests that most of the elderly in agricultural settlements in Kuantan have inadequate intake of folate, in which 93.6% of the subjects did not meet their RNI for total folate (Figure 1).

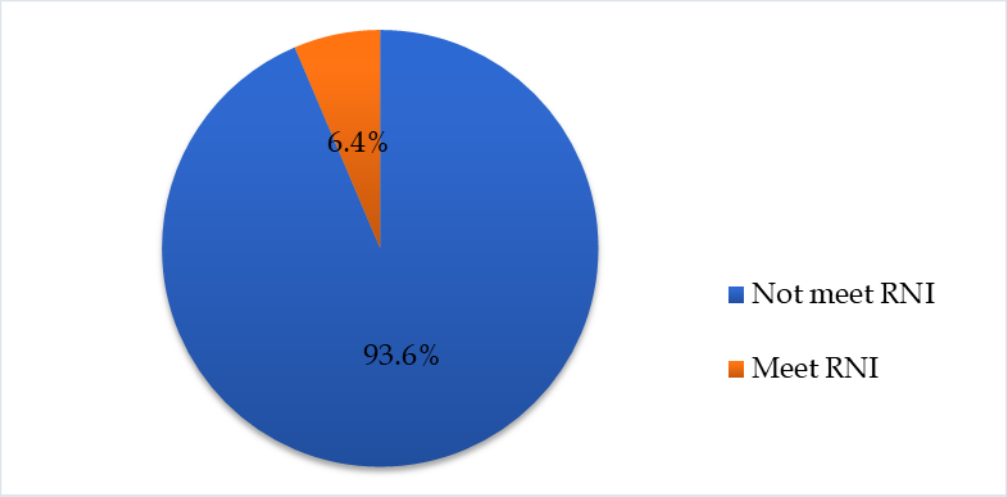


**Figure 1** Frequency of subjects who meet the RNI for folate

According to RNI 2017, total vitamin $B_6$ requirement for elderly aged 60 years old and above is different between male (1.7 mg/day) and female (1.5 mg/day). Table 3 indicates that there was a significant difference between total vitamin $B_6$ intake and RNI for vitamin $B_6$ for both male and female elderly ($p$ = 0.001). The mean values for both male and female were 50% and 59.3% respectively lower than the 1.7 mg/day for male and 1.5 mg/day for female of recommended vitamin $B_6$ intake, which suggest that most of the elderly in Kuantan have inadequate intake of vitamin $B_6$.

**Table 3** Comparison of total vitamin $B_6$ intake of elderly with RNI

| Vitamin $B_6$ Requirement / Intake | | | | |
|---|---|---|---|---|
| **Gender** | **RNI (mg/day)** | **Mean (±SD) of Vitamin $B_6$ Intake (mg/day)** | **% difference from RNI** | ***p*-value** |
| **Male** | 1.7 | 0.85 (0.738) | -50 | 0.001* |
| **Female** | 1.5 | 0.61 (0.479) | -59.3 | 0.001* |

*$p$-value < 0.05

In total, 92% of the subjects did not meet their RNI for total vitamin $B_6$ intake which account for most of the participants while only 8% meet the recommendation. (Figure 2).

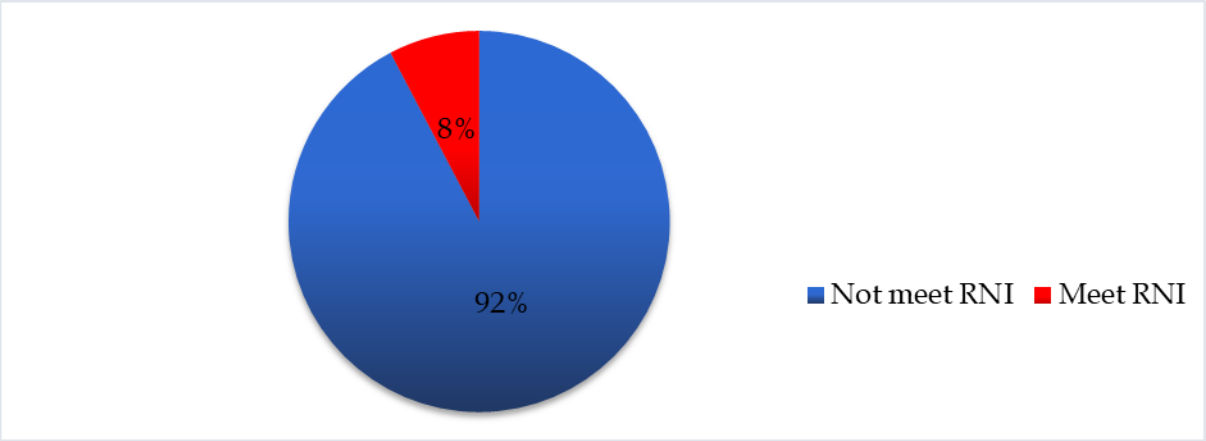


**Figure 2** Frequency of subjects who meet the RNI for vitamin $B_6$

According to RNI 2017, vitamin $B_{12}$ requirement for both male and female elderly aged 60 years old and above subjects is 4.0 mcg/day. Table 4 shows that there was no significant difference between total vitamin $B_{12}$ intake and RNI for vitamin $B_{12}$ among the elderly subjects.

**Table 4** Comparison of total vitamin $B_{12}$ intake of the elderly subjects with RNI

| Vitamin $B_{12}$ Requirement / Intake | | | |
|---|---|---|---|
| **RNI (mcg/day)** | **Mean (±SD) of Vitamin $B_{12}$ Intake (mcg/day)** | **% Difference from RNI** | ***p*-value** |
| 4.0 | 3.71 (3.03) | - 7.25 | 0.398 |

*$p$-value < 0.05

The mean value (3.71 ± 3.03 mcg/day) was about 7% lower than the recommended value of 4.0 mcg/day. Figure 3 indicates that 63% of the subjects did not meet their RNI for vitamin $B_{12}$ (Figure 3).

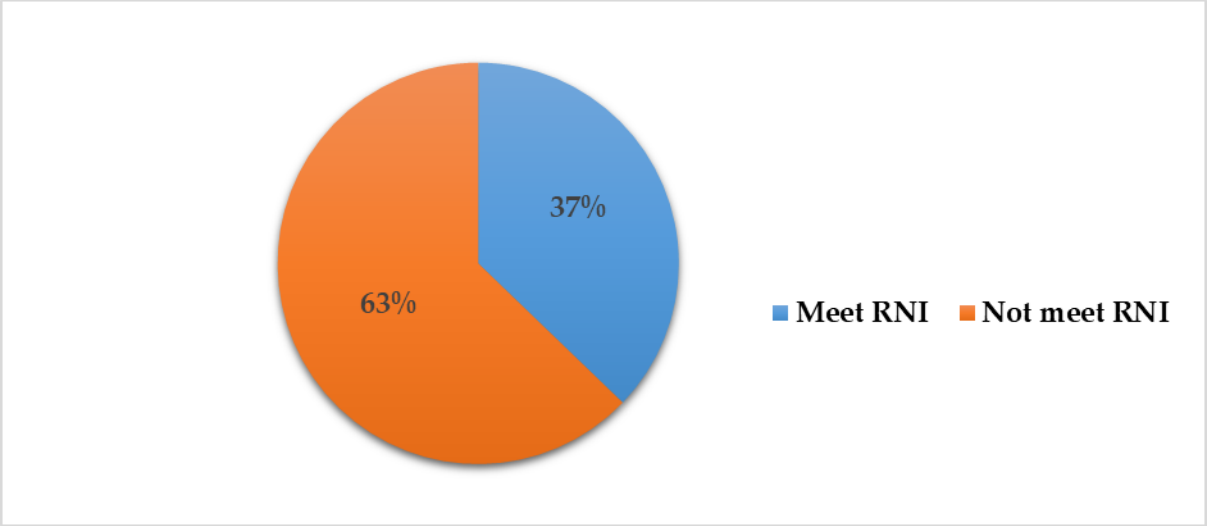


**Figure 3** Frequency of subjects who meet the RNI for vitamin $B_{12}$

### Cognitive Status of Elderly

Total MMSE score is 30 marks and the minimum marks that indicate normal cognitive status is 24 out of 30. 62.8% of total elderly subjects were identified with normal cognitive function; whereas frequency of subjects in mild and severe cognitive impairment categories were 24.4% and 12.8% respectively (Figure 4).

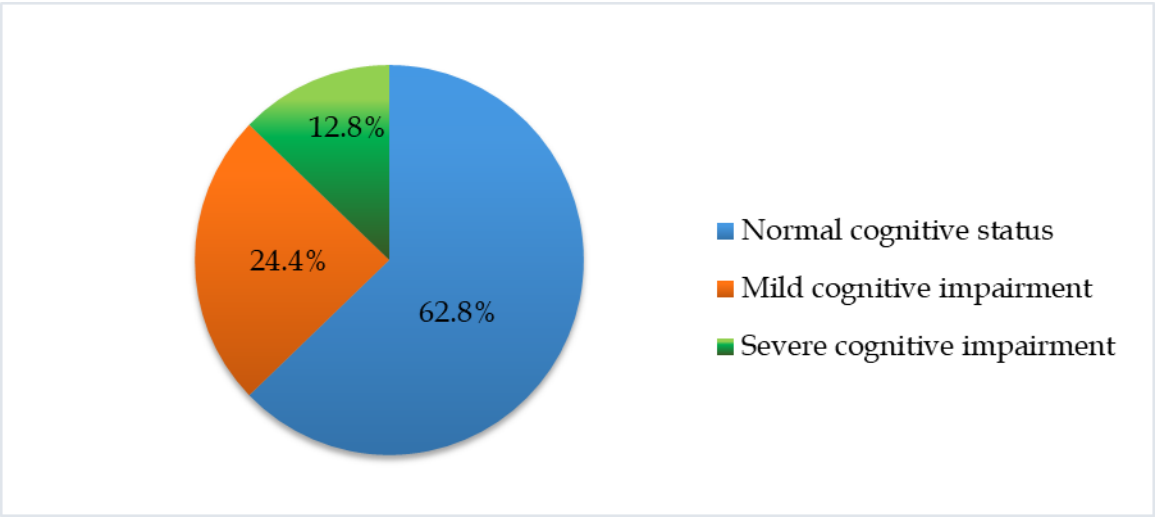


**Figure 4** Frequency of subjects based on each MMSE score category

### Association between B Vitamins Intake and Cognitive Status

Table 5 shows that there were no significant association between B vitamins intake (folate, vitamin $B_6$ and $B_{12}$) and cognitive status of elderly.

**Table 5** The association between B vitamins intake and cogntive status of elderly

| | Cognitive Status | |
|---|---|---|
| **Vitamins** | ***R*** | ***p*-value** |
| **Total Folate** | 0.06 | 0.61 |
| **Total Vitamin $B_6$** | 0.07 | 0.54 |
| **Total Vitamin $B_{12}$** | 0.07 | 0.55 |

## DISCUSSION

The present study shows that folate and vitamin $B_6$ intake of elderly was inadequate and significantly below the RNI 2017 for Malaysian. However, significant difference was not detected for vitamin $B_{12}$. Finding of inadequate folate intake is in line with a study by Morris et al. (2005). The researcher found that more than 56% of the subjects had low folate intake compared to recommendation; with the mean intake was 67% lower than RDA. This may be contributed to lack of fruits and green leafy vegetables intake among the elderly. According to Cheong et al. (2017), more than 80% of Malaysian elderly have inadequate intake of fruits and vegetables. It is noteworthy that majority of elderly in the present study were deficient in vitamin $B_6$. This finding is consistent with findings from previous study (Kjeldby, Fosnes, Ligaarden & Farup, 2013), which indicated that elderly may consume less food rich in vitamin $B_6$. Thus, the inclusion of more meat, poultry, liver and whole grains in daily meals are strongly recommended as these foods contain an abundant amount of vitamin $B_6$ to overcome the deficiency.

Finding of cognitive status in our study is parallel with a previous study conducted by Sherina, Rampal and Mustaqim (2004) among elderly in Mukim Sepang. They found that only 22.4% from the total subjects had cognitive impairment, thus suggested that most of the subjects had no cognitive impairment. Another similar study was conducted in Penang and the result showed only 11% of elderly subjects affected by cognitive impairment (Rashid, Azizah & Rohana, 2012). Rashid, Azizah and Rohana (2012) also found that another psychosocial factors such as increasing age, being unmarried, unemployed and living alone may predict higher prevalence of cognitive impairment among elderly. Therefore, elderly and their caregivers should be well informed about the associated risks to minimize cognitive status deterioration.

Although cognitive impairment is identified as one of the consequences of B vitamins deficiency (Kim et al., 2014; Morris, 2007; Skully, 2014), the present study showed no significant association between B vitamins intake and cognitive status. This finding however, is consistent with previous studies conducted by McNeill et al. (2011) and Arioğulet al. (2005). One of the possible explanations for this finding is related to the use of MMSE. MMSE is a validated screening tool for cognitive impairment, but not a diagnostic tool (O'Leary et al., 2012), hence it may have less sensitivity to detect cognitive change (Folstein, Folstein & McHugh, 1975). Meanwhile, a recent systematic review and meta-analysis demonstrated that B vitamins have no significant association with cognitive function; but this result need to be interpreted cautiously due to heterogeneity of the data from included studies (Ford & Almeida, 2019). In addition, Sakuma et. al. (2019) highlighted that vitamin D intake significantly associated with cognitive status; which might be the case for our study findings.

On the other hand, it was found that low vitamin $B_{12}$ status influenced cognitive function of older adults with cognitive impairment (Clarke et al., 2003; Kim et al., 2014). In a cohort study, Morris et al. (2012) found no association between vitamin $B_{12}$ deficiency and cognitive status over 8 years of follow-up. Since majority of elderly in the present study have a good cognitive status, this could be a possible explanation for a non-significant association between B vitamins intake and cognitive status of the elderly. These accumulating evidences suggest that the relationship between B vitamins and the cognitive function is complex and not completely understood (Lewerin, 2006), with lack of scientific evidence (O'Leary et al., 2012). Therefore, further investigation to discover the association is warranted through high quality study.

Limitation of the study is related to the method used to collect information on dietary intake, which is diet history method. This is due to the fact that all subjects are elderly age 60 years old and above; thus some of the subjects may not remember what they have eaten or usually eat. Food record method is suggested for future studies as this technique does not involve memorization of food intake, hence may produce more reliable dietary intake data. However, it should be noted that this study is at the forefront in providing baseline information related to B vitamins intake and cognitive status among elderly in agricultural settlements.

The present study suggests specific area for intervention. First, the B vitamins intake could be improved by provision of nutrition information to the elderly and their caregivers through variety of intervention programmes. The nutrition information that worth to be delivered include the serving size and the types of food rich in B vitamins. Adequate information may help this population to practice healthy eating and thus meet the recommended intake as outlined in RNI. Lastly, the programme should also be individually tailored as food preference differs across individuals. As a result, improvement and adequate nutrients intake could be achieved.

## CONCLUSION

The high prevalence of inadequate intake of B vitamins among elderly is evident in this study. Therefore, an increased risk of cognitive impairment among elderly may be expected although there was no significant association between B vitamins intake and cognitive status. Screening for B vitamins deficiencies among elderly can be one of the strategies to reduce the risk of comorbidities and also to minimize the progression of cognitive status deterioration to achieve optimum health and nutritional status.

## ACKNOWLEDGEMENTS

We were grateful to the elderly respondents who have been involved in this research. This study was funded by Research Initiative Grant Scheme (RIGS 15-033-0033), International Islamic University Malaysia.

**REFERENCES**


Agarwal, R. (2011). Vitamin B deficiency and cognitive impairment in elderly population. *The Indian Journal of Medical Research*, 134(4), 410-412.

Alzheimer 's Disease Foundation Malaysia (2016). Alzheimer's in Malaysia. Available online from http://adfm-imu.com/alzheimers-in-malaysia/

Arioğul, S., Cankurtaran, M., Dağli, N., Khalil, M., & Yavuz, B. (2005). Vitamin B12, folate, homocysteine and dementia: are they really related?. *Archives of Gerontology and Geriatrics*, *40*(2), 139-146.

Cheong, S. M., Jasvinder, K., Lim, K. H., Ho, B. K. Surthahar, A. & Ambigga, D. (2017). Prevalence and factors influencing fruit and vegetable consumption among Malaysian elderly. *International Journal of Public Health and Clinical Sciences*, 4(1), 41-52.

Clarke, R., Refsum, H., Birks, J., Evans, J. G., Johnston, C., Sherliker, P., Ueland, P. M. (2003). Screening for vitamin B-12 and folate deficiency in older persons. *The American Journal of Clinical Nutrition*, 77(5), 1241-1247.

Department of Statistics Malaysia (2018). Current population estimates, Malaysia 2017-2018. Available online:
https://www.dosm.gov.my/v1/index.php?r=column/pdfPrev&id=c1pqTnFjb29HSnNYNUpiTmNWZHArdz09

Folstein, M. F., Folstein, S. E. & McHugh, P.R. (1975) "Mini-mental state". A practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research*, 12 (3), 189–198.

Ford, A. H., & Almeida, O. P. (2019). Effect of Vitamin B Supplementation on Cognitive Function in the Elderly: A Systematic Review and Meta-Analysis. *Drugs & Aging*, *36*(5), 419-434.

Fishman E. (2017). Risk of Developing Dementia at Older Ages in the United States. *Demography*, 54(5), 1897-1919.

Kim, H., Kim, G., Jang, W., Kim, S. Y. & Chang N. (2014). Association between intake of B vitamins and cognitive function in elderly Koreans with cognitive impairment. *Nutrition Journal*, 13(1), 1-2.

Kjeldby, I. K., Fosnes, G. S., Ligaarden, S. C. & Farup, P. G. (2013). Vitamin B6 deficiency and diseases in elderly people – a study in nursing homes. *BMC Geriatrics*,
13(1), 1-13.

O' Leary, F., Allman-Farinelli, M. & Samman, S. (2012). Vitamin B12 status. Cognitive decline and dementia: A systematic review. *British Journal of Nutrition*, 108, 1948-1961.

McNeill, G., Jia, X., Whalley, L. J., Fox, H. C., Corley, J., Gow, A. J., ... & Deary, I. J. (2011). Antioxidant and B vitamin intake in relation to cognitive function in later life in the Lothian Birth Cohort 1936. *European Journal of Clinical Nutrition*, *65*(5), 619.

Morris, M. C., Evans, D. A., Bienias, J. L., Tangney, C. C., Hebert, L. E., Scherr, P. A. & Schneider, J. A. (2005). Dietary folate and vitamin B12 intake and cognitive decline among community-dwelling older persons. *Archive of Neurology*, 62(4), 641-645.

Morris, M. C., Jacques, P. F., Rosenberg, I. H. & Selhub, J. (2007). Folate and vitamin B-12 status in relation to anemia, macrocytosis, and cognitive impairment in older Americans in the age of folic acid fortification. *The American Journal of Clinical Nutrition*, 85(1), 193-200

Morris, M. C., Selhub, J., & Jacques, P. F. (2012). Vitamin B-12 and folate status in relation to decline in scores on the mini-mental state examination in the Framingham Heart Study. *Journal of the American Geriatrics Society*, 60(8), 1457–1464.

Mulder, C., Scheltens, P., Barkhof, F., Gundy, C., Verstraeten, R. A. & de Leeuw, F.E. (2005). Low vitamin B6 levels are associated with white matter lesions in Alzheimer's disease. *Journal of the American Geriatrics Society*, 53(6), 1073-1084.

Nikmat, A. W., Hawthorne, G. & Al-Mashoor, S. H. A. (2011). Dementia in Malaysia: Issues and challenges. *ASEAN Journal of Psychiatry*, 12(1), 1-7.

Rashid, A. K., Azizah, A. M. & Rohana, S. (2012). Cognitive impairment among the elderly Malays living in rural Malaysia. *Medical Journal of Malaysia*, 67(2), 186-189.

Reay, J. L., Smith, M. A., & Riby, L. M. (2013). B vitamins and cognitive performance in older adults: Review. *ISRN Nutrition*, 1-7. doi.org/10.5402/2013/650983.

Sakuma, M., Kitamura, K., Endo, N., Ikeuchi, T., Yokoseki, A., Onodera, O., ... & Narita, I. (2019). Low serum 25-hydroxyvitamin D increases cognitive impairment in elderly people. *Journal of Bone and Mineral Metabolism*, *37*(2), 368-375.

Sherina, M. S., Rampal, L., & Mustaqim, A. (2004). Cognitive impairment among the elderly in a rural community in Malaysia. *Medical Journal of Malaysia*, *59*(2), 252-257.

Skully, R. (2014). Essential nutrient requirements of the elderly. *Nutrition and Dietary Supplements*, 6, 59-68.

Suzana, S., Boon, P. C., Chan, P. P. & Normah, C. D. (2013). Malnutrition risk and its association with appetite, functional and psychosocial status among elderly Malays in an agricultural settlement. *Malaysian Journal of Nutrition*, 19(1), 65-76.