

Relationship between Traditional Malaysian Vegetables (Ulam) Intake and Cognitive Status Among Middle-aged Adults from Low Cost Residential Areas (Hubungan antara Pengambilan Ulam dan Status Kognitif Dewasa Pertengahan Usia dari Kawasan Perumahan Kos Rendah)

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ABSTRACT

Ulam is fresh traditional Malaysian vegetables which normally consumed in raw form or after a short blanching process. It contains high antioxidants and polyphenols. However, there is limited study about the relationship between ulam consumption and cognitive status. Thus, a cross sectional study was conducted to determine the relation with cognitive function among 132 middle-aged Malays adults (45-59 years old), recruited by convenient sampling from low income residences in Klang Valley. Respondents were interviewed to obtain data on sociodemography, dietary intake and total ulam intake and also measured for anthropometric parameters at respective community centres. Cognitive status was measured using Digit Span (attention and working memory), Rey auditory verbal learning test (RAVLT) (verbal memory) and comprehensive trail making test (CTMT) (cognitive flexibility). The average ulam intake by the respondents was 15.1 ± 8.2g/day and the top five highest consumed ulam were petai (68.1%), pucuk paku (62.9%), ulam raja (56.8%), pegaga (54.6%) and kesum (44.7%). There was a significant correlation between ulam intake with Digit Span ($r = 0.265, p = 0.006$), total immediate recall of RAVLT ($r = 0.427, p < 0.001$) and CTMT ($r = 0.257, p = 0.007$). Analysis of multiple regression indicated that total ulam intake was a significant predictor for Digit Span ($R^2 = 0.152, p < 0.05$), RAVLT ($R^2 = 0.335, p = 0.001$) and CTMT ($R^2 = 0.310, p < 0.001$). In conclusion, this study showed that ulam has the potential to protect against cognitive decline, however, randomized control trials should be conducted to determine the efficacy of the ulam as neuroprotective agent.

Keywords: Ulam; cognitive; low income; middle-aged; Malay

ABSTRAK

Ulam ialah sayur-sayuran tradisional Malaysia yang sering dimakan secara mentah atau selepas proses dicelur. Ia mengandungi kandungan antioksidan dan polifenol yang tinggi. Walau bagaimanapun, kajian mengenai hubungan antara pengambilan ulam dengan fungsi kognitif adalah terhad. Oleh itu, kajian hirisan lintang ini dijalankan untuk menentukan hubungan antara pengambilan ulam dengan fungsi kognitif dalam kalangan dewasa Melayu pertengahan usia (45-59 tahun), dipilih secara persampelan mudah dari kediaman kos rendah di Lembah Klang. Responden ditemu bual untuk mendapatkan data mengenai sosiodemografi, pengambilan makanan, jenis dan kekerapan pengambilan ulam. Parameter antropometri juga diukur di pusat komuniti masing-masing. Status kognitif diuji menggunakan Digit Span, Rey's Auditory Verbal Learning Test (RAVLT) dan Comprehensive Trial Making Test (CTMT). Jumlah pengambilan ulam oleh responden adalah 15.1 ± 8.2 g sehari dan lima ulam yang paling kerap dimakan ialah petai (68.1%), pucuk paku (62.9%), ulam raja (56.8%), pegaga (54.6%) dan kesum (44.7%). Terdapat hubungan yang signifikan antara pengambilan ulam dengan Digit Span ($r = 0.265, p = 0.006$), RAVLT total immediate recall ($r = 0.427, p < 0.001$) dan CTMT ($r = 0.257, p = 0.007$). Analisa regresi pelbagai bilang mendapati jumlah pengambilan ulam merupakan preditor bagi fungsi kognitif yang dinilai berdasarkan Digit Span ($R^2 = 0.152, p < 0.05$), RAVLT ($R^2 = 0.335, p = 0.001$) dan CTMT ($R^2 = 0.310, p < 0.001$). Kesimpulannya, kajian ini menunjukkan ulam berpotensi untuk mengurangkan risiko penyusutan fungsi kognitif, namun, ujian kawalan rawak harus dilaksanakan untuk menentukan keberkesanan ulam sebagai agen neuroprotektif.

Kata kunci: ulam, kognitif, pendapatan rendah, pertengahan usia, Melayu

INTRODUCTION

According to the National Health and Morbidity Survey 2015, 24.8% to 27.7% of middle-aged adults (45 to 59 years old) had higher prevalence as compared to 19.6 to 20.1% (≥ 60 years old) in Malaysia facing poor mental health issues, as assessed using General Health Questionnaire

(GHQ). In addition, low household income group (<RM3000) Malaysians (30.8%) also had higher prevalence of poor mental health as compared to higher household income group (> RM3000) Malaysians (27.5%) (Institute for Public Health 2015). Using a similar tool, Rosli et al. (2017) reported that 40% among those from low income residential areas in Klang Valley had poor mental health and

cognitive status assessed by General Health Questionnaire (GHQ) and Rey's Auditory Verbal Learning Test (RAVLT) and related to low flavonoids intake, particularly from fruits and vegetables. Another source of flavonoids in Malaysian diet is *ulam*. It is fresh traditional Malaysian vegetables that is usually consumed in raw form or after a short blanch in boiled water (Huda-Faujan et al. 2007). It is commonly eaten among Malays and sometimes mixed together with herbs and spices (Reihani & Azhar 2012). The most common *ulam* that consumed by Malaysian population were *petai* (*Parkia speciosa*), *pegaga* (*Centella asiatica*), *selom* (*Oenanthe javanica*) and *ulam raja* (*Cosmos caudatus*). Median total *ulam* intake by Selangor population was 40g/person/day (Nurul Izzah et al. 2012). There are more than 120 species of *ulam* available in Malaysia (Shukri et al. 2011) and the Malaysian Dietary guidelines has recommended Malaysian population to increase *ulam* consumption as it contains high fiber and antioxidants (National Coordinating Committee on Food and Nutrition 2010). Some of the *ulam* has been used as medicinal plants or therapeutic agents as it contains high polyphenols and antioxidant content (Chan et al. 2014; Kongkachuichai et al. 2015; Reihani & Azhar 2012). Several animal studies have reported that *ulam* could exhibit several medicinal properties such as lowering the blood sugar, systolic pressure, blood cholesterol and inflammation states (Amalia et al. 2012; Bachok et al. 2014; Bora, Arora & Shri 2011; Perumal et al. 2014). However, human studies are limited to prove that *ulam* is beneficial in exhibiting these properties. A few available recent clinical trial studies conducted locally reported that the beneficial of *ulam* consumption on controlling blood sugar of 101 diabetes patients after eight weeks by Cheng et al. (2015) and improving attention, short-term memory and mood among 35 middle-aged women after 6 weeks supplementation by Shahar et al. (2015). Patterns of vegetables and fruits consumption among Malaysian population study has been carried out by Nurul Izzah et al. (2012), Intan Hafizah et al. (2015) and Othman et al (2013) studies. National Health Morbidity Survey (2015) reported that there was a significant higher prevalence of poor mental health and cognitive status among low income population (B40 population) as compared to high income population (Institute for Public Health (IPH) 2015). In addition, the recent qualitative study to identify the factors of *ulam* consumption among low income Malaysian population reported that they consumed *ulam* instead of other types of vegetables as *ulam* is cheaper and easily accessible in Klang Valley (Mohd Zuhaimi 2018). Thus, this study aimed to determine the types and frequency of ever consumed *ulam* and its relationship with a multidomain of cognitive status including working memory, attention, verbal memory and executive memory among middle-aged adults from low income residences in Klang Valley.

MATERIALS AND METHODS

STUDY DESIGN AND SAMPLING

A total of 132 middle-aged Malay adults in Klang Valley were recruited through convenient sampling from March to September in the year 2018. Data collection was carried out at community centres of low-income residences in Klang Valley of Malaysia (i.e. Cheras and Sentul). The inclusion criteria of this study were aged range from 45 to 59 years old Malay adults and able to communicate well in Malay or English languages. The exclusion criteria of this study were adults with history of mental health illness (i.e. Alzheimer's disease, schizophrenia, history of stroke), physical disability and chronic kidney disease or undergo dialysis. This study has obtained the ethical approval (code UKM PPI/111/8/JEP-2018-210) from the National University of Malaysia Medical Research and Ethics Committee.

DATA COLLECTION

The socio-demography information such as name, date of birth, gender, phone number, address, marital status, years of formal education, occupation and household income were obtained. In addition, the respondents were asked about their smoking behavior and the presence of chronic diseases that were defined as a self-reported condition based on diagnosis by the physician.

Anthropometric measurements including height, weight, waist circumference, hip circumference and body composition were obtained using standard protocol (International Society for the Advancement of Kinanthropometry 2001). All anthropometric measurements were performed with the respondents wearing light clothing without socks and shoes. Body weight was measured using a digital weighing scale (SECA, Seca 803, USA) to the nearest 0.1 kg. Height was measured using stadiometer (SECA, Seca 213 Portable, USA) to the nearest 0.5 cm. Body Mass Index (BMI) was calculated from the height and weight measured by the researcher using formula [weight in kg/(height in m)²] to determine either a person has normal BMI, underweight, overweight, or obesity based on World Health Organisation (2006) classification. Waist circumference was measured using a lufkin tape with the accuracy to ± 0.1 cm. Body composition was measured using Bioelectrical Impedance Analysis (Biospace, InBody S10 Body Composition analyser, Korea).

Dietary history questionnaire (DHQ) was used to analyse respondents' dietary pattern and to calculate that nutrients intakes (Shahar et al. 2000). Detailed interview was conducted to gather information including the type, amount, method of cooking and frequency of respondents' food intake in a period of a week. In addition, dietary reporting was calculated by using formula energy intake divided with basal metabolic rate (energy intake/basal metabolic rate). Basal metabolic rate was calculated using Ismail et al. (1998) formula. Classification of dietary reporting was then referred to Bingham (1994) study. In

addition, a Food Frequency Questionnaire (vegetables and fruits) which consists of 58 vegetables, 24 *ulam-ulam* and 26 fruits commonly consumed by Malaysian population was used in this study. It was used to identify the types, frequency and quantity of *ulam* consumption among the respondents which has been used in the study of Shahar et al. (2008) and Nurul Izzah et al. (2012). The respondents were asked for the frequency of *ulam* intake ranging from daily, weekly, monthly and yearly. Pictures of *ulam* were provided during the data collection in order to enable the respondents to recognize the ever consumed *ulam* throughout this year. Portion sizes consumed by the respondents were taken as an indication based on household measurement and the use of pictures from the Atlas of Food Exchanges and Portion Sizes in order to calculate the total intake of food and *ulam* (Suzana et al. 2002). The total polyphenol intake of the respondents was calculated from the sum of the polyphenol content in vegetables and fruits daily consumption based on Phenol Explorer online database (Neveu et al. 2010).

Cognitive function was assessed using three cognitive domains: Digit Span Test, Rey Auditory Verbal Learning Test (RAVLT) and Comprehensive Trail Making Test (CTMT). Mood state was assessed by using Profile of Mood States (POMS). The Digit Span subtest of the Wechsler Scales was used to assess verbal working memory and short-term memory of the respondents (Wechsler 1997). The respondents were asked to complete 2 tasks given: Digit Forward and Digit Backward. The respondents were required to repeat the number sequence in the same order as read by the researcher for Digits Forward whereas the respondents were required to repeat the number sequence in the reverse order for Digits Backward task. The test was discontinued after a score of 0 on both trials on any item. The sum of the digit forward and digit backward was recorded.

Malay version of Rey Auditory Verbal Learning Test (RAVLT) was used to evaluate verbal learning and memory (Jamaluddin et al. 2009). The RAVLT which consists of 5 trials with 15-word list was read by researcher one second per item and then asked the respondents to recall the words after each trial. The number of words correctly recalled at each time point was recorded (Jamaluddin et al. 2009).

Comprehensive Trail Making Test (CTMT) consists of 5 trials which was used to detect the frontal lobe deficit, problems with psychomotor speed, visual search, attention and executive functioning of the respondents (Gray 2006). Prior to completing all trails, researcher explained clearly about the instructions to connect a series of stimuli (numbers, expressed as numerals or in word form, and letters) by following the sequence. The time taken to finish the tasks for each trial was recorded (Smith et al. 2008).

The Profile of Mood States (POMS) formulated by McNair et al. (1971) was used to assess transient and distinct mood states (i.e. Tension, Anger, Vigor, Fatigue, Depression and Confusion). The respondents were asked about how they have been feeling in the past week ranging

from "not at all" to "extremely", a five-point scale to assess their mood states. The total of Mood disturbance was calculated by using the formula as shown:

$$\text{Total Mood Disturbance (TMD)} = (\text{Tension} + \text{Depression} + \text{Anger} + \text{Fatigue} + \text{Confusion}) - (\text{Vigour} + \text{Esteem related affect})$$

STATISTICAL ANALYSIS

All the statistical analyses were performed by Statistical Package for the Social Sciences (SPSS) version 23.0 software (IBM Corporation, Armonk, NY, USA). Dietary intake was analysed using Nutritionist Pro (Axxya Systems Stafford, USA) and compared with Recommended Nutrient Intake (RNI) 2017 in Malaysians population by National Coordinating Committee on Food and Nutrition (2017). The total polyphenol intake was estimated using Phenol Explorer (Neveu et al. 2010). However, the total polyphenol of *ulam* which was not listed in this database was estimated by referring Lim (2015) study. Socio-demography information, anthropometric measurements, dietary intake, *ulam* intake and cognitive status data were analysed by descriptive analysis and reported as percentage, mean and standard deviation. The normality test was tested prior to the specific test analysis. Kolmogorov-Smirnov test and skewness ratio were used in normality test. Since the total *ulam* intake was not normally distributed, Log₁₀ data transformation method was used to transform the data into normally distributed data. The relationship between the *ulam* consumption and cognitive status was analysed by using Pearson correlation. Raw scores of the Digit Span Test and Comprehensive Trail Making Test (CTMT) were converted into scale scores and T scores respectively to reconstruct the original distribution of raw scores for each age groups. Multiple regression was used to identify the predictors of cognitive status (Digit Span, RAVLT and CTMT).

RESULTS

As shown in Table 1, a total of 132 middle-aged Malay adults consisted of 30 men (30.3%) and 92 women (69.7%), age ranged from 45 to 59 years old, participated in this study. The mean age of the respondents was 66 ± 6 years old. Majority of the respondents were married (80.3%). The mean of years of formal education of the respondents was 11.1 ± 2.3 years. Majority of the respondents were still working (60.6%) and the household income was RM2711 ± 2223 per month. Only 8.8% of the respondents were smokers. With respect to self-reported medical conditions, 40.7% of the respondents had hypertension, 32.7% of the respondents had hyperlipidemia, 15.9% of the respondents had diabetes and 18.6% of the respondents had gout. Figure 1 shows that nearly half of the total respondents were overweight (48.5%) followed by obese (28%) and normal (22%).

TABLE 1. Characteristics of middle-aged adults from low cost residential areas (n = 132)

Characteristics	Mean \pm SD or %
Demographic data	
Age, years	52.3 \pm 4.7
Female	69.7%
Married	80.3%
Education, years	11.1 \pm 2.3
Household income, RM	2711 \pm 2223
Working	60.6%
Smoker	8.8%
Self-reported medical conditions	
Hypertension	40.7%
Hyperlipidemia	32.7%
Type 2 Diabetes	15.9%
Gout	18.6%
Anthropometric measurements	
Height, cm	156.7 \pm 8.4
Weight, kg	69.4 \pm 14.4
Waist circumference, cm	91.8 \pm 11.9
Hip circumference, cm	104.4 \pm 9.6
Fat percentage, %	36.9 \pm 8.5
Muscle mass, kg	24.7 \pm 5.9
BMI (kg/m ²)	28.1 \pm 4.8
Dietary intake	
Total vegetables intake (non-ulam), g/day	141.3 \pm 18.6
Total fruits intake, g/day	125.9 \pm 26.9
Total ulam intake, g/day	15.1 \pm 8.2
Energy intake, kcal/day	1861 \pm 369
Carbohydrate intake, g/day	221.5 \pm 54.9
Protein intake, g/day	68.4 \pm 15.6
Fat intake, g/day	77.7 \pm 20.6
Total polyphenol intake, mg	3795 \pm 1858
Cognitive domain	
Digit span, score	9.5 \pm 2.2
Total immediate RAVLT, score	39.4 \pm 11.0
Total CTMT, score	187.8 \pm 46.8
Mood assessment	
Tension, score	4.8 \pm 3.7
Fatigue, score	5.5 \pm 3.9
Esteem-related affect, score	15.6 \pm 3.6
Anger, score	4.2 \pm 2.2
Vigour, score	10.3 \pm 3.3
Depression, score	3.7 \pm 1.9
Confusion, score	3.9 \pm 1.9
Total Mood Disturbance, score	96.3 \pm 16.7

With respect to dietary reporting, majority of the respondents (66.7%) were normal reporting their dietary intake based on classification by Bingham (1994). As compared to Malaysian Recommended Nutrient Intake (NCCFN 2017), majority of the respondents met the requirements except for calcium intake (4.5%) (Figure 2).

With respect to cognitive status, three cognitive domains scores were reported in Table 1 expressed as mean and standard deviation. However, the average total mood disturbance (TMD) score of the respondents was 96.3 \pm 16.7 (<100) which indicated the respondents had mood disturbance.

As shown in Table 2, the top 10 most common or highest intake of ever consumed ulam or traditional vegetables by the respondents were *petai* (*Parkia speciosa*), *pucuk paku* (*Diplazium esculentum*), *ulam raja* (*Cosmos caudatus*), *pegaga* (*Centella asiatica*), *kesum* (*Polygonum minus*), *pucuk ubi kayu* (*Manihot esculenta*), *selom* (*Oenanthe javanica*), *pucuk gajus* (*Anacardium occidentale*), *jering* (*Pithecellobium jiringa*) and *cekur manis* (*Sauropus androgynus*). Majority of the respondents consumed ulam in raw form except *pucuk paku* (*Diplazium esculentum*) and some of the respondents consumed *kesum* (*Polygonum minus*), *cekur manis* (*Sauropus androgynus*), *pucuk labu* (*Cucurbita pepo*) and *daun selasih* (*Ocimum sanctum*) in cooked or after short blanching process.

As shown in Table 3, a higher intake of ulam consumption was correlated with a better cognitive performance as assessed using Digit Span Test ($r = 0.265$, $p = 0.006$), RAVLT (total immediate recall) ($r = 0.427$, $p < 0.001$) and CTMT ($r = 0.257$, $p = 0.007$). In addition, intake of *petai* (*Parkia speciosa*) ($r = 0.402$, $p < 0.001$), *pucuk paku* (*Diplazium esculentum*) ($r = 0.438$, $p < 0.001$), *ulam raja* (*Cosmos caudatus*) ($r = 0.513$, $p < 0.001$) and *pegaga* (*Centella asiatica*) ($r = 0.358$, $p = 0.003$) was positively correlated with RAVLT (total immediate recall). Further, consumption of *petai* (*Parkia speciosa*) ($r = 0.296$, $p < 0.05$), *pucuk paku* (*Diplazium esculentum*) ($r = 0.306$, $p < 0.05$), *ulam raja* (*Cosmos caudatus*) ($r = 0.352$, $p = 0.003$) and *pegaga* (*Centella asiatica*) ($r = 0.306$, $p < 0.05$) was positively correlated with CTMT. Analysis of the multiple linear regression indicated that total ulam intake was associated positively with three cognitive domains, i.e. digit span ($p < 0.05$), RAVLT ($p < 0.01$) and CTMT ($p < 0.001$) with variability of 10.1%, 29.5% and 26.9% respectively as shown in Table 4.

DISCUSSION

This study reported an average total ulam intake of 15.1 \pm 8.2g/day (half serving per day), which was lower than an early study by Nurul Izzah et al. (2012) which was 40 g/day among 242 respondents in Selangor, Malaysia. This situation may be contributed by our research location was in Klang Valley particularly Cheras and Sentul (urban area), where many respondents reported that they could not buy their favourite ulam in the market. Various types of ulam that they mentioned were only available in rural areas. *Petai* (*Parkia speciosa*), *pucuk paku* (*Diplazium esculentum*), *ulam raja* (*Cosmos caudatus*), *pegaga* (*Centella asiatica*) and *kesum* (*Polygonum minus*) were the top five highest consumed ulam by the subjects. Another Malaysia study showed quite similar results that the most consumed ulam or traditional vegetables by using 24 hours food record were *petai* (*Parkia speciosa*) followed by *pegaga* (*Centella asiatica*), *selom* (*Oenanthe javanica*) and *ulam raja* (*Cosmos caudatus*) among 242 respondents in Selangor, Malaysia (Nurul Izzah et al. 2012), however,

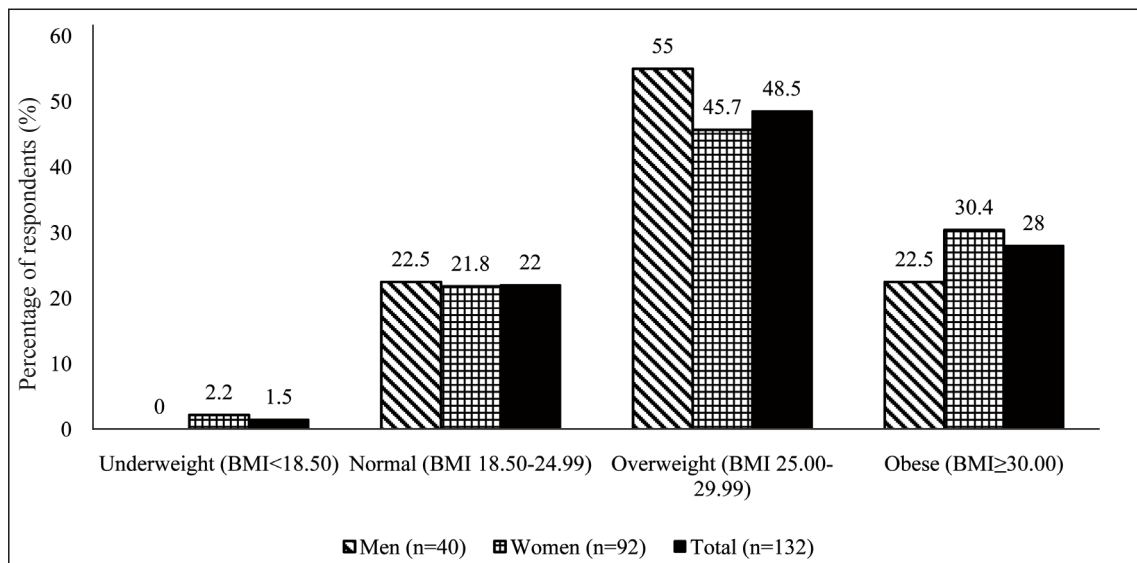


FIGURE 1. Percentage of respondents according to BMI classification by WHO (2006)

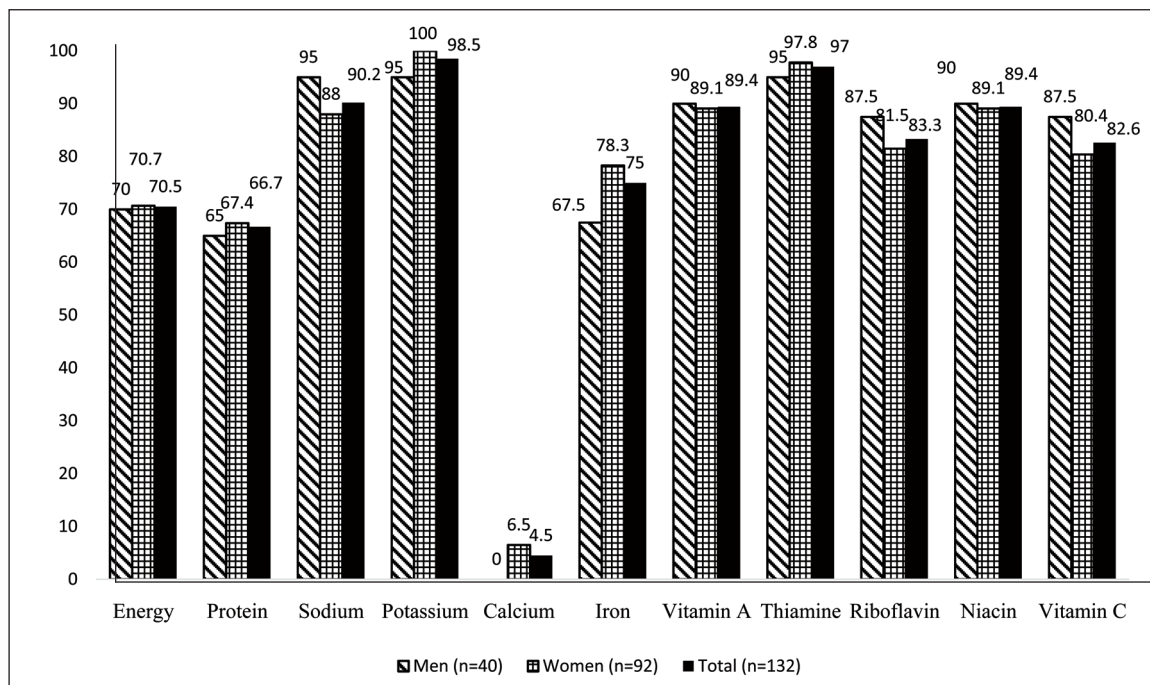


FIGURE 2. Percentage of respondents who met RNI (2017) requirements

the limitation of Nurul Izzah et al. (2012) study was the researcher didn't report the information regarding ways of consumption of *ulam* by the respondents. In the present study, the information about the ways of consumption of *ulam* or traditional Malaysian vegetables either in raw or cooked form was reported and it was found that majority of the respondents consumed *ulam* in raw form with *sambal* and *budu*. In recent study reported that there was a significant reduction of polyphenol content and antioxidant activities after thermal processing such as frying and cooking (Gunathilake & Ranaweera 2018). Thus, *ulam* is recommended to be consumed in raw as compared to cooking form to preserve its polyphenol content.

With respect to cognitive function assessment, neuropsychological batteries such as Digit Span Test, RAVLT and CTMT were used in this study to assess the attention or working memory, verbal memory and executive functioning respectively. This study found that the higher the *ulam* consumption, the better the cognitive status assessed by neuropsychological batteries by using Pearson correlation. After including other confounding factors such as age, education years, sex, household income and total polyphenol intake, the total *ulam* intake still showed positive correlation with all neuropsychological batteries in multiple linear regression. *Ulam* has been reported to be rich in antioxidants and polyphenols, and previous studies

TABLE 2. Percentage of the specific ever consumed *ulam* or traditional vegetables by the respondents and the way of consumption

<i>Ulam-ulam</i> /traditional Malaysian vegetables	Scientific name	Total respondents (n = 132)		Ways of consumption (n = 132)	
		N	%	Raw, n (%)	Boiled/ Cooked, n (%)
<i>Petai</i>	<i>Parkia speciosa</i>	90	68.10	8(8.9)	82(91.1)
<i>Pucuk paku</i>	<i>Diplazium esculentum</i>	83	62.90		83(100)
<i>Ulam raja</i>	<i>Cosmos caudatus</i>	75	56.80	75(100)	
<i>Pegaga</i>	<i>Centella asiatica</i>	72	54.55	72(100)	
<i>Kesum</i>	<i>Polygonum minus</i>	59	44.70	24(40.7)	35(59.3)
<i>Pucuk ubi kayu</i>	<i>Manihot esculenta</i>	57	43.18	57(100)	
<i>Selom</i>	<i>Oenanthе javanica</i>	46	34.85	46(100)	
<i>Pucuk gajus</i>	<i>Anacardium occidentale</i>	42	31.82	42(100)	
<i>Jering</i>	<i>Pithecellobium jiringa</i>	34	25.76	34(100)	
<i>Cekur manis</i>	<i>Sauropus androgynus</i>	21	15.91	5(23.8)	16(76.2)
<i>Pucuk betik</i>	<i>Carica papaya (leaves)</i>	20	15.15	20(100)	
<i>Bunga betik</i>	<i>Carica papaya (flower)</i>	17	12.88	17(100)	
<i>Pucuk labu</i>	<i>Cucurbita pepo</i>	15	11.36	2(13.3)	13(86.7)
<i>Pucuk mengkudu</i>	<i>Morinda citrifolia</i>	12	9.09	12(100)	
<i>Pucuk kaduk</i>	<i>Piper sarmentosum</i>	12	9.09	12(100)	
<i>Pucuk cemperai</i>	<i>Champereia griffithi</i>	9	6.82	9(100)	
<i>Buah putat</i>	<i>Barringtonia racemosa</i>	9	6.82	9(100)	
<i>Daun selasih</i>	<i>Ocimum sanctum</i>	8	6.06	2(25)	6(75)
<i>Beluntas</i>	<i>Pluchea indica</i>	2	1.52	2(100)	

has proven it could exhibit medicinal properties such as anti-diabetic, anti-hypertensive, and neuroprotective (Bachok et al. 2014, Amalia et al. 2012, Ajaykumar et al. 2012). Polyphenols and antioxidants are essential to protect against cognitive decline through attenuation of apoptosis and prevent oxidative stress (Sinclair & Guarente 2006). Previous randomized controlled trials of *ulam* supplementation have been reported in improving cognitive function of middle-aged and older adults. The *Polygonum minus* (*kesum*) supplementation has improved both attention and memory among middle aged women after 6 weeks intervention in Malaysia (Shahar et al. 2015). Furthermore, *Ginkgo biloba* and *Centella asiatica* have improved cognitive impairment related with aging and other disorders such as Alzheimer and dementia (Gambhir 2008; Puttarak et al. 2017; Solomon et al. 2002). A study by Udani (2013) reported there was a significant improvement in executive functioning, cognitive flexibility, reaction time and working memory after the intervention by providing 20 healthy subjects in United States with *Superulam* capsules for 3 weeks. *Superulam* capsule is the combination extracts of *sireh* (*Piper betle*), turmeric (*Curcuma longa*), *pegaga* (*Centella asiatica*), curry leaves (*Murraya koenigii*), *selasih* (*Ocimum basilicum*), *kesum* (*Polygonum minus*) and *ulam raja* (*Cosmos caudatus*). When comparing the treatment group to placebo, the data showed a significant decrease in mood, anger and tension (Udani 2013). Based on the conclusion made by a systematic review in Thailand, due to different doses and standardization of *Centella asiatica* (*pegaga*) used in the interventions, no strong evidence can be concluded to prove

that *Centella asiatica* can improve cognitive function. However, most of the studies reported that *Centella asiatica* capsule supplementation could improve working memory, alertness and relieve anger (Puttarak et al. 2017). Thus, out of three studies that have mentioned above could not conclude that *ulam* could truly improve cognitive function and mood, however, more randomized control trials in evaluating the efficacy of this *ulam* in neuroprotection should be conducted in future.

In addition, *ulam* or traditional Malaysian vegetables also contain a couples of flavonoids such as quercetin and quercetin glycosides which are beneficial in neurocognitive protection (Cheng, Barakatun-Nisak et al. 2015). Flavonoids are more likely to exert beneficial effects in the brain by preventing neurodegeneration, inhibiting neuroinflammation and reducing age-related cognitive decline (Vauzour et al. 2008). Many of the studies examining the positive effects of flavonoids has focused on quercetin, which is widely distributed in traditional vegetables (Manach et al. 2004). Quercetin extracted from vegetables has been reported to permeate across the blood brain barrier and has the ability to impede the neuron cell death by breaking down hydrogen peroxide which can cause oxidative stress to form water molecules (Costa et al. 2016; Ferri et al. 2015). Quercetin and quercetin-3-glucuronide were reported to have an impact on gamma-aminobutyric acid (GABA) receptors producing sedation, anxiolytic or anticonvulsive effects (Jäger & Saaby 2011).

There are several limitations in this study. The study design of this study was cross sectional study and the evidence to indicate that high *ulam* intake is beneficial

TABLE 3. Relationship between total *ulam* and 5 highest ever consumed *ulam* intake with cognitive function and mood assessment

Neuropsychologica batteries	<i>Petai (Parkia speciosa)</i>		<i>Pucuk paku (Diplazium esculentum)</i>		<i>Ulam raja (Cosmos caudatus)</i>		<i>Pegaga (Centella asiatica)</i>		<i>Kesum (Polygonum minus)</i>		Total <i>ulam</i>	
	Correlation (r)	p-value	Correlation (r)	p-value	Correlation (r)	p-value	Correlation (r)	p-value	Correlation (r)	p-value	Correlation (r)	p-value
Digit span RAVLT	0.205	0.075	0.185	0.118	0.107	0.375	0.112	0.370	0.104	0.438	0.265**	0.006
Total immediate recall	0.402***	<0.001	0.438***	<0.001	0.513***	<0.001	0.358**	0.003	0.229	0.084	0.427***	<0.001
Comprehensive Trail Making Test (CTMT)	0.296*	0.011	0.306*	0.012	0.352**	0.003	0.306*	0.012	0.177	0.184	0.257**	0.007
Mood assessment												
Tension	0.067	0.563	0.225	0.056	-0.012	0.918	0.080	0.525	0.095	0.476	0.034	0.722
Fatigue	-0.105	0.894	0.207	0.079	-0.070	0.561	-0.100	0.424	-0.098	0.462	-0.039	0.330
Esteem-related effect	-0.029	0.804	0.221	0.060	0.001	0.993	0.027	0.832	-0.087	0.517	0.175	0.683
Vigor	0.029	0.803	0.099	0.406	0.129	0.282	-0.217	0.079	-0.019	0.888	0.138	0.446
Anger	0.045	0.697	0.207	0.079	-0.022	0.855	-0.121	0.332	-0.006	0.963	-0.093	0.066
Depression	0.013	0.909	0.086	0.469	0.052	0.666	-0.099	0.428	-0.037	0.781	-0.073	0.149
Confusion	-0.020	0.862	-0.108	0.364	-0.058	0.633	-0.104	0.405	-0.039	0.773	-0.075	0.433
Total Mood Disturbance	0.023	0.843	0.049	0.680	-0.050	0.678	-0.041	0.742	0.001	0.991	-0.118	0.218

*Significant at $p < 0.05$, using Pearson correlation test

**Significant at $p < 0.01$, using Pearson correlation test.

***Significant at $p < 0.001$, using Pearson correlation test

TABLE 4. Multiple linear regression for factors associated with three cognitive domains (digit span, RAVLT and CTMT)

Variables	Digit span			RAVLT			CTMT					
	R	R ²	Adjusted R ²	p value	R	R ²	Adjusted R ²	p value	R	R ²	Adjusted R ²	p value
Age ^b				0.120				0.033				0.182
Sex ^d				0.981				0.396				0.004
Education, years ^{acd}				0.017				0.001				0.009
Household income	0.390	0.152	0.101	0.516	0.579	0.335	0.295	0.579	0.557	0.310	0.269	0.886
Total polyphenol intake				0.953				0.631				0.114
Total <i>ulam</i> intake ^{ace}				0.020				0.001				<0.001

^a Significant at $p < 0.05$ in digit span test

^b Significant at $p < 0.05$ in RAVLT.

^c Significant at $p < 0.01$ in RAVLT

^d Significant at $p < 0.01$ in CTMT

^e Significant at $p < 0.001$ in CTMT

Dependent variable: Digit Span score, RAVLT score and CTMT score

to improve cognitive status was limited. Furthermore, the *ulam* intake information was collected by using Food Frequency Questionnaire which was self-reported results, food weighing method and observational studies were recommended as dietary assessment in future. This study also did not quantify the flavonoids content in *ulam*, thus, the total polyphenol intake was only estimated by using Phenol Explorer database.

With respect to future directions, there is limited pharmacological treatment for Alzheimer's-related memory loss and dementia, thus it is important to assess the cognitive impairment at an early stage and exploring treatment and prevention measures are very crucial. To date, human-based studies are limited resulted in inadequate evidence-based conclusions in the effects neuroprotective effects of *ulam*. Therefore, it is recommended to conduct human trials to determine the efficacy of polyphenol rich *ulam* that can contribute to reduction of cognitive decline. Biofluid samples including urine and blood should be collected and analyzed using metabolic profiling methods to discover the novel biomarkers of *ulam* intake and cognitive function-associated metabolites.

CONCLUSION

In conclusion, the total *ulam* intake/day was 15.1 ± 8.2 g and the top five highest consumed *ulam* or traditional Malaysian vegetables were *petai* (*Parkia speciosa*), *pucuk paku* (*Diplazium esculentum*), *ulam raja* (*Cosmos caudatus*), *pegaga* (*Centella asiatica*) and *kesum* (*Polygonum minus*). This study showed that *ulam* has potential to protect against cognitive decline, however, randomized control trial should be conducted in future to determine the efficacy of the *ulam* in neuroprotection.

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