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Nutrient Intake Pattern of Vegetarians and Non-Vegetarians in Kuala Lumpur, Malaysia

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Abstract: Vegetarians adhering to a well-planned diet are assumed to meet nutrient requirements. This study was designed to evaluate the nutrient intake of adult vegetarians and non-vegetarians in Kuala Lumpur. A cross-sectional comparison between three types of diet practices was carried out in Kuala Lumpur, with 35 respondents in each group (non-vegetarian, ovolacto-vegetarian and strict-vegetarian). Anthropometric indices such as weight and body fat composition were measured using TANITA electronic balance scale, while three-day dietary recalls was assessed using a computer dietary analysis software programme, Nutritionist-pro. Statistical analysis had shown non significant difference in the three diet practices with respect to anthropometric indices. The benefits of vegetarian practices were obviously presented in the dietary intake of nutrients. Both ovolacto-vegetarians and strict-vegetarians had significantly higher mean dietary intake of fiber, folate, magnesium, vitamin A and vitamin C than non-vegetarians ($p<0.01$). Surprisingly, some of the potential nutrient deficiencies among strict-vegetarians such as calcium, iron and zinc achieved the Recommended Nutrient Intakes (RNI) for Malaysia. However, the dietary habits of vegetarians were very heterogeneous and some of them did not comply with the requirements for calcium, iron zinc and vitamin B_{12}. Malaysian vegetarians in this study generally have a better nutrient intake than non-vegetarians. Education on proper meal planning should be implemented among vegetarians to prevent potential nutritional deficiencies.

Key words: Nutrient intake, strict-vegetarian, ovolacto-vegetarian, non-vegetarian

INTRODUCTION

The prevalence of vegetarianism appears to be increasing in Malaysia. This practice was associated with contentment, animal welfare, environmental benefit and health reason (Lea and Worsely, 2002).

Numerous studies have been conducted in the past two decades to investigate the health benefits of vegetarian diet practices. Vegetarians have been reported to have higher consumption of plant foods; the antioxidant components in vegetables and fruits are the most well known factors that alter the risk of chronic diseases (Khor *et al*., 2000; Szeto *et al*., 2004). Besides, researches have highlighted that a vegetarian diet have a lower intake of cholesterol, saturated fat and total fat and a higher intake of fiber then their non-vegetarian counterparts. Therefore, the incidence of chronic diseases and condition such as obesity, coronary artery disease, hypertension, diabetes, cancer and mortality are lower in vegetarians (Craig and Mangels, 2009; Rajaram and Sabaté, 2000; Yen *et al*., 2008).

Reviews by expert groups showed that a well planned and varied vegetarian diet which follows the dietary guidelines and happen to meet the requirements of the Recommended Dietary Allowance for nutrients was perfectly consistent with good health (American Dietetic Association, 2003; National Academy of Science, 2003). However, there is a risk that meat and other animal products are excluded without being replaced by nutritionally equivalent vegetarian foods. This worry has been increasing especially in Malaysian vegetarians where the main drives for practicing vegetarian diet were based on religion, environment issues and concerns of world hunger (Lin, 2008; Then and Chan, 2007). The lack of interest and knowledge about vegetarian meal planning may contribute to inadequate intake of nutrients.

In general, a poorly planned vegetarian diet may have low intakes of protein, iron, calcium, zinc, vitamin B_2, vitamin B_{12} and vitamin D. Studies in Western populations have consistently reported a lower intake of iron, calcium and vitamin B_{12} among vegetarians and their counterparts (Key *et al*., 2006; Larson and Johansson, 2006). The consumption of non-heme iron from plants origin has a lower bioavailability than heme

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iron from animal products. Thus, the actual amount of iron absorption from vegetables may be considerably lower than iron from meat origin. In addition, the only reliable dietary sources of vitamin B_{12} are animal-derived products such as meat, eggs and dairy products that are restricted in strict-vegetarians. Therefore, chronic deficiency of iron and vitamin B_{12} among strict-vegetarian predisposed them to anemia especially during pregnancy period (Key *et al*., 2006; Huang *et al*., 1999; Wilson and Ball, 1999). Besides, numerous studies have shown that strict-vegetarians who avoid consumption of dairy products in their early age tend to have lower intake of calcium and they are at higher risk of osteoporotic fractures in elderly (Lin, 2008; Larson and Johansson, 2006).

Various epidemiological studies on nutritional status of vegetarians have been conducted in the western countries. However, these results may not be applicable for the Malaysian population due to differences in the dietary pattern as people from different regions consumed different types of food with varying amount. In contrast, the study of local vegetarian nutrition is sparse. Consequently, there is a need for comprehensive information on actual dietary intake of Malaysian vegetarians. Therefore, the aim of our study is to evaluate the nutrient intake of adult vegetarians in Kuala Lumpur population.

MATERIALS AND METHODS

This cross-sectional survey was conducted from February to May 2011 in seven locations around Kuala Lumpur, Malaysia. The locations were selected on the basis of convenience sampling and subjects aged between 20-40 years were included. The vegetarian subjects were recruited from several vegetarian restaurants, universities and members of associations that practice vegetarian diet. Non-vegetarians were matched with gender and age group with vegetarians. For the purpose of this study, strict vegetarians was defined as people, who consume food of plant origin only; ovolacto-vegetarians were people who consume predominantly foods of plant origin, with eggs, milk and other dairy products being the only food of animal origin and non-vegetarians were defined as people eating food of both plant and animal origin (Wilson and Ball, 1999). Subjects were included if they had practiced typical diet for more than 6 months and were planning to continue this diet. A total of 105 subjects consented to participate in this study.

Body composition: Body weight and body fat composition were measured using a TANITA TBF-310 electronic balance scale. Respondents were weighed barefooted. The parameters measured were body weight, body mass index, fat percentage, fat mass, total body water and fat free mass. Body Mass Index (BMI) was classified according to the WHO (2000).

24-hour dietary recall: All subjects were required to fill up 3 days of 24-hour dietary recall questionnaire that was guided by Suzana *et al*. (2000). Each dietary recall was taken at least 2 days apart, including 2 weekdays and 1 weekend. During a 24-hour dietary recall, subject was asked to recall every food that was consumed during the previous day. Food models, pictures and measuring cups were served as visual tools to increase the accuracy of describing the intake. The food reported by respondent was entered into the computerized dietary analysis software programme Nutritionist-pro version 4.0 using the United States Department of Agriculture (USDA) Nutrient Database. Food items that were not included in the database programme was substituted to the closest possible food or represented using its ingredients.

Statistical analysis: All statistical analysis of the data were carried out using 'Statistical Package for Social Science' (SPSS) version 19.0. Dietary data were tested for normality. The parametric analysis of the nutrient intake among the three groups were done using one-way-ANOVA test. Following that, post-hoc test was performed using Tukey test statistic. Non-parametric analysis was done using Kruskal-Wallis one-way ANOVA followed by Mann-Whitney U-test with Bonferroni adjustment test. The significant value of $p<0.05$ was applied.

RESULTS

The total number of respondents who completed the study comprised of 105 people with 35 respondents in each group (Table 1). Mean age was 24.97±7.90 for non-vegetarians, 25.83±6.60 for ovolacto-vegetarians and 26.23±6.61 for strict-vegetarians. The ovolacto-vegetarians and strict-vegetarians had been following their dietary pattern for a mean of 3.41±3.9 years (ranged from 0.6 to 2 years) and 3.42±3.94 years (ranged from 0.6 to 2 years), respectively. Religion became the main drive for practicing vegetarian diet among vegetarians (41.4%). More vegetarians consumed supplement than non-vegetarians. Vitamin C, vitamin B complex and *spirulina* were the most common supplements being taken. Non-vegetarian controls who participated in this study did not differ significantly from either ovolacto-vegetarians or strict-vegetarians with respect to anthropometric indices such as BMI, percentage body fat, fat free mass, total body water and fat mass (Table 2).

The dietary intake has been verified by basal metabolic rate of respondents. The daily intake of macronutrients, energy and fiber are shown in Table 3.

Table 1: Demographic background of study respondents (n = 105)

Characteristic	Non-vegetarians (n = 35) n (%)	Ovolacto-vegetarians (n = 35) n (%)	Strict-vegetarians (n = 35) n (%)	Total n (%)
Sex				
Male	15 (42.9)	14 (40.0)	15 (42.9)	44 (41.9)
Female	20 (57.1)	21 (60.0)	20 (57.1)	61 (58.1)
Reason of practice				
Health	-	7 (20.0)	16 (45.7)	23 (21.9)
Religion	-	14 (40.0)	16 (45.7)	28 (41.4)
Environmental health	-	14 (40.0)	3 (8.6)	17 (16.2)
Supplement consumption	-	12 (34.3)	3 (8.6)	15 (14.3)

Table 2: Anthropometric characteristics of respondents (n = 105)

Characteristics	Non-vegetarian (n = 35) Mean±SD	Ovolacto-vegetarians (n = 35) Mean±SD	Strict-vegetarians (n = 35) Mean±SD	p-value
Body mass index (kg/m^2)	21.96±4.66	22.45±4.96	20.51±3.10	0.285
Percentage body fat (%)	21.95±7.49	25.15±10.26	20.68±7.22	0.237
Fat free mass (kg)	47.22±11.18	44.51±7.38	42.29±8.49	0.252
Total body water (kg)	34.57±8.18	32.58±5.41	31.43±5.28	0.283
Fat mass (kg)	13.93±7.28	16.27±10.85	11.38±4.97	0.110

Table 3: Energy, macro nutrients, fiber and lipid profile intake of respondents (n = 105)

Macro nutrients	Non-vegetarians (n = 35) Mean±SD	Ovolacto-vegetarians (n = 35) Mean±SD	Strict-vegetarians (n = 35) Mean±SD	p-value
Total Energy Intake (kcal)	1875.43±636.43	1817.54±500.54	1893.22±613.75	0.811
Carbohydrate (g)	237.44±92.04^{ab}	277.12±83.84	275.44±69.40	0.004**
Percent of total energy	50.86±6.96^{ab}	61.04±7.78	59.94±9.27	<0.001***
Protein (g)	82.82±29.18^{a}	62.74±23.71	76.67±49.02	0.006**
Percent of total energy	18.04±3.93^{ab}	13.65±3.10	15.38±4.09	<0.001***
Total Fat (g)	65.48±29.27	52.02±19.42	54.63±31.14	0.129
Percent of total energy	31.09±6.06^{ab}	25.31±5.99	24.68±6.51	<0.001***
Cholesterol (mg)	297.09±147.52^{ab}	128.05±117.20^{c}	26.59±41.18	<0.001***
Total Dietary Fiber (g)	7.48±5.00^{ab}	15.61±9.29	16.79±9.98	<0.001***

*Significant value at p<0.05, **Significant value at p<0.01, ***Significant value at p<0.001.
[a]Significantly different between non-vegetarians and ovolacto-vegetarians (p<0.05).
[b]Significantly different between non-vegetarians and strict-vegetarians (p<0.05).
[c]Significantly different between ovolacto-vegetarians and strict-vegetarians (p<0.05).

Table 4: Micronutrient intake of respondents (n= 105)

Minerals	Non-vegetarians (n = 35) Mean±SD	Ovolacto-vegetarians (n = 35) Mean±SD	Strict vegetarians (n = 35) Mean±SD	p-value
Calcium (mg)	628.40±505.51^{b}	806.77±766.61	842.15±868.70	0.043*
Iron (mg)	19.97±8.25	21.20±9.61	21.43±15.36	0.871
Zinc (mg)	6.51±3.32	7.09±5.70	9.90±13.85	0.324
Folate (mcg)	161.58±110.39^{ab}	267.92±117.80	271.79±213.38	<0.001***
Vitamin A (RE)	1266.80±962.48^{ab}	1854.50±3833.84	1132.06±671.83	0.002**
Vitamin C (mg)	68.96±40.81^{ab}	142.94±78.60	111.52±62.11	<0.001***
Vitamin B1 (mg)	1.06±0.62	1.26±0.48	1.21±0.89	0.071
Vitamin B2 (mg)	1.47±0.69	1.53±0.64	1.29±0.73	0.227
Vitamin B3 (mg)	19.28±16.89^{ab}	12.87±12.51	10.84±5.27	<0.001***
Vitamin B5 (mg)	1.75±1.07^{b}	1.92±0.98^{c}	1.20±1.00	0.004**
Vitamin B6 (mg)	1.23±0.68	1.09±0.61	1.24±0.89	0.678
Vitamin B7 (mcg)	18.33±16.48^{b}	16.63±12.62^{c}	8.62±19.48	<0.001***
Vitamin B12 (mcg)	2.37±1.42^{ab}	0.82±0.65^{c}	0.52±1.64	<0.001***

*Significant value at p<0.05, **Significant value at p<0.01, ***Significant value at <0.001

Despite the finding that total energy intakes of the three dietary groups were similar, the non-vegetarians derived a significantly higher proportion of their energy from total fat and protein compared to vegetarians. The intake of trans-fatty acid was significantly higher (p = 0.008) in non-vegetarian compared to ovolacto-vegetarian. Besides, cholesterol intake was significantly different between all three dietary groups, with the non-vegetarians consuming the most and strict-vegetarians the least (p<0.001). Total dietary fiber was significantly higher in vegetarians compared to non-vegetarians. Vegetarians consumed less than half the cholesterol of non-vegetarians and vice versa for total dietary fiber.

The intake of minerals and vitamins are represented in Table 4. Among the minerals, calcium, iron and zinc were known to be deficient in a poorly planned

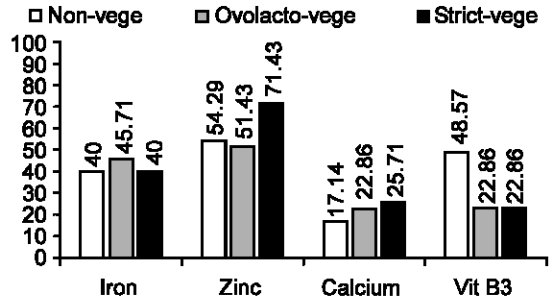

Fig. 1: Percentage of respondents that achieved Malaysian RNI 2005

vegetarian diet. However, the dietary intake of calcium was significantly higher ($p = 0.043$) in strict-vegetarian compared to non-vegetarian. There was no significant different in total iron and zinc intake between all three dietary groups.

As for vitamins, vegetarians consumed a significantly higher amount of vitamin A, vitamin C and vitamin D as compared to non-vegetarians. However, vegetarians have a low intake of certain types of vitamin B, with a significant lower intake of B3, B7 and B12 ($p<0.001$).

When the results are compared with the Recommended Nutrient Intakes (RNI) for Malaysia (2005), some of the potential nutrient deficiencies among strict-vegetarians such as calcium, iron and zinc have a higher mean intake than RNI Malaysia. However, the nutrients mentioned above had shown a large value of standard deviation which reflect that the dietary habits of vegetarians varied considerably. This was further proven when about half of the strict-vegetarian respondents have just achieved RNI of Malaysia (Fig. 1).

DISCUSSION

The mean Body Mass Index (BMI) of the respondents in the three groups lied within the normal range and no significant difference was observed between groups. Besides, other indicators of body fat composition such as fat mass and percentage body fat were found to be not significant between the three groups. Results from this study are in good accordance with those of several local studies such as Lin (2008) Than and Chan (2007) that involved 80 subjects who had been practicing vegetarian diet for 5 years and 9 years respectively (Lin, 2008; Then and Chan, 2007). This result was also consistent with those found by Key *et al.* (2009) that recruited a larger sample size (20, 601 vegetarians) with mean vegetarian diet pattern for 8 years (Key *et al.*, 2009). Therefore, it is postulated that although vegetarians are known to have a lower intake of saturated fat and vice versa for total fiber intake, the outcome of BMI does not differ with non-vegetarian as it was predicted to be influenced by other factors such as lifestyle habit and variation of dietary pattern in different countries.

According to the results obtained, the energy intake was insufficient for all the three groups. This result was in disagreement with the majority of western countries' studies (Larson and Johansson, 2006; Wilson and Ball, 1999). Nevertheless, local and Taiwan studies showed a similar outcome in the context that the subjects of our study did not achieve the RNI for Malaysia for energy (Lin, 2008; Then and Chan, 2007; Huang *et al.*, 1999). These findings might be due to under reporting of the foods consumed or the norms of the Asian Chinese population that generally have a lower intake of energy. Therefore, further studies with longer dietary record should be conducted to delineate a more reliable data.

Vegetarians generally have a better macro nutrients profile. They showed a healthy contribution of carbohydrate, protein and fat percentage in their daily consumption that was recommended by RNI for Malaysia (55-70% for carbohydrate, 10-15% for protein and 20-30% for fat). On the other hand, non-vegetarians illustrate a disproportionate intake of carbohydrate and protein in their daily energy intake, with relatively lower contributions of energy from carbohydrate (50.86%) and higher contributions from protein (18.04%). This might be due to high consumption of animal protein in non-vegetarian diets. Besides, cholesterol and trans fatty acid intake was significantly higher in non-vegetarians than in the other two groups of vegetarians. These were supported by most of the studies such as by Lin (2008); Deriemaeker *et al.* (2010). The mean intake of cholesterol in non-vegetarian males raised a concern as their mean daily intake exceeds 300mg/day. The high consumption of cholesterol among non-vegetarians was known to be a contributing factor in arteriosclerotic plaque formation which will subsequently lead to coronary heart disease and stroke (Khor *et al.*, 2000). Dietary fiber intake was noted to be significantly higher in vegetarians compared to non-vegetarians, as was supported by Yen *et al.* (2008); Wilson and Ball (1999). High fiber intake had gain popularity in lowering the risk of obesity, diabetes, hypertension, cardiovascular disease, colorectal cancer, breast cancer and ovarian cancer (Rajaram and Sabaté, 2000).

As in minerals, a poorly planned vegetarian diet was known to have a lower contribution of calcium and zinc. It was pleasant to find that the Malaysian strict-vegetarians succeed in their 'dietary-battle' to meet the recommended intake. This was further proven in local studies done by Lin who conducted a food frequency questionnaire among vegetarians in Klang (Lin, 2008). The result obtained agreed with the statement that Malaysian vegetarians frequently consumed milk and soy products which are rich in calcium. However, the

Table 5: Comparison of mean nutrient intake of respondents with Malaysian RNIs 2005

Nutrients	Recommended nutrient intakes	Non-vegetarians (n = 35) Mean±SD	Ovolacto-vegetarians (n = 35) Mean±SD	Strict-vegetarians (n = 35) Mean±SD
Total Energy Intake (kcal)	Male = 2440	2139.05±564.67	1754.06±394.75	1967.03±517.37
	Female = 2000	1677.72±627.58	1859.86±565.62	1837.86±685.07
Carbohydrate (g)	Male = 200-330	262.80±93.07	265.75±56.66	281.51±67.78
	Female = 180-230	218.43±88.83	284.69±98.56	270.89±71.99
Protein (g)	Male = 62	102.96±28.81	59.00±14.54	79.35±30.08
	Female = 55-70	67.72±18.75	65.23±28.32	74.66±60.20
Cholesterol (mg)	Male = <300	352.63±147.52	150.08±128.75	30.05±45.39
	Female = <300	255.44±136.56	113.36±109.59	23.99±38.72
Calcium (mg)	Male = 800	860.34±697.97	893.95±1098.65	834.44±391.32
	Female = 800	454.45±154.90	748.64±453.47	847.93±1111.55
Iron (mg)	Male = 14	23.19±9.52	22.04±9.68	21.43±9.05
	Female = 29	17.56±6.37	20.65±9.76	21.44±19.02
Zinc (mg)	Male = 6.7	8.57±3.79	5.57±2.13	8.79±5.83
	Female = 4.9	4.96±1.83	8.11±7.03	10.74±17.79

high standard deviation of calcium in Table 5 reflected that the dietary habits of vegetarians varied considerably. This was further proven when only a quarter of the ovolacto-vegetarians and strict-vegetarians achieved RNI for Malaysia for calcium (22.86 and 25.71%, respectively). Female ovolacto-vegetarians were also noted to have insufficient intake of calcium. Studies had shown that inadequate intake of calcium in pre-menopausal women increases their likelihood of having reduced bone density which will lead to osteoporosis after menopause (Heaney, 2000).

The iron status of female vegetarians was in great concern as the non-heme iron originating from plant products has a lower bioavailability. Besides, phytates that is naturally found in legumes, nuts and whole grains can inhibit iron absorption. Therefore, National Academy of Sciences suggested that the amount of iron required by vegetarian is 1.8 times higher than the recommended iron intake (National Academy of Science, 2003). However, it was observed that the iron intake of female vegetarians was even lower than the RNI for Malaysia (Table 5). Chronic insufficient intake of iron will predispose female vegetarians to iron deficiency anemia especially during pregnancy period.

The higher intake of vitamin C and vitamin A among vegetarians was consistent with results from previous studies by Yen *et al.* (2008); Huang *et al.* (1999). According to the Ministry of Health Malaysia, egg yolk was stated as a good source of vitamin A (Ministry of Health Malaysia, 2005). This has been reflected to be true as the dietary intake of vitamin A in ovolacto-vegetarian was the highest. On the other hand, fruits and green leafy vegetables are the main sources of vitamin C. Several antioxidant components in this study were found to be significantly higher among vegetarians such as vitamin C, vitamin A and copper. Thus, vegetarians may have a better antioxidant profile that have a better prevention on chronic diseases such as coronary artery disease, chronic obstructive pulmonary disease and certain cancers including lungs, esophagus, stomach, colon, breast and cervical cancers (Rajaram and Sabaté, 2000).

Vitamin B_3 and B_{12} were found to be significantly lower among vegetarians compared with non-vegetarians. The mean intake of vitamin B_{12} among strict-vegetarians in the present study was the lowest among the three dietary groups. Besides, only 22% of the subjects from each vegetarian group achieved the RNI for vitamin B_3. This is worrying because only 21% of vegetarian subjects consumed supplements. Studies have shown that a long-term ovolacto-vegetarian diet may cause a low vitamin B_{12} status in pregnant women and they are at higher risk of causing neural tube defect in the newborn (Koebnick *et al.*, 2004). Thus, strict-vegetarians are advised to consume B complex supplement as food plants does not contain vitamin B_{12}.

Conclusion: In conclusion, Malaysian vegetarians generally achieved most of the nutrients recommended by the RNI for Malaysia. In addition, this dietary pattern is healthier due to higher intake of fiber, folate, vitamin C and vitamin A with lower consumption of cholesterol and trans fat. However, the dietary habits of vegetarians were very heterogeneous and some of them did not comply with the requirement for calcium, iron zinc and vitamin B_{12}. Therefore, we proposed that education on proper meal planning should be implemented among vegetarians to prevent potential nutritional deficiencies.

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