J Community Nutrition 2(2) : 110~118, 2000

Original Article

Cardiovascular Risk Factors among Malaysian Urban Vegetarians

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ABSTRACT

One-hundred thirty-six Chinese men and women who are members of the Malaysian Confucian Association from Kuala Lumpur city and suburbs were included in the study. They have been vegetarians for a mean period of about 6 years with the majority of them(91.2%) as lacto/ovo vegetarians. The average age of the male and female subjects is 33 and 34 years respectively. The mean BMI for the men and women are 22.5±2.4kg/m^2 and 21.9±3.1kg/m^2 respectively. The mean levels of serum total cholesterol, HDL-chol and LDL-chol for men are 4.27±0.77, 1.11±0.26 and 2.60±0.54mmol/L, while the corresponding values for women are 4.24±0.81, 1.34±0.29 and 2.41±0.28mmol/L. All the respondents showed TC/HDL-chol levels within the normal cut-off point of <5.8mmol/L. Majority of the subjects showed normal range levels for serum retinol, carotenoids and α-tocopherol. The mean systolic blood pressure for men and women are 122±16mmHg and 115±13mmHg, while their diastolic blood pressure are 82±7mmHg and 79±7mmHg respectively. Hypertension was found at a higher prevalence in men(17.6%) than among the women (7.1%). None of the respondents smoke cigarettes while approximately two-thirds of them carry out physical exercise at least once a week. Their usual dietary intake includes frequent consumption of a wide variety of vegetables, fruits, nuts and legumes. In summary, Malaysian vegetarians have a low cardiovascular risk based on their health-oriented lifestyle. (*J Community Nutrition* 2(2) : 110~118, 2000)

KEY WORDS : vegetarians · body mass index · blood lipids · carotenoids and α-tocopherol.

Introduction

Cardiovascular disease is a leading cause of mortality in both developed and developing regions. It is estimated that ischaemic heart disease and cerebrovascular disease accounted for 62.5% and 45.3% of total deaths in 1990 in developed and developing regions respectively(Murray & Lopez 1996). The authors projected that by the year 2000, non-communicable diseases are expected to account for seven out of every ten deaths in the developing countries.

In Malaysia, cardiovascular disease has been the main cause of death since the early 1970s. The mortality rate of cardiovascular disease increased from 24.6 per 100,000 persons in 1965 to 57.2 in 1991(Khor 1994). Currently it is responsible for about 28% of all deaths that are medically inspected and certified(Malaysia Ministry of Health 1997). Several studies in the past decade have documented high prevalence of cardiovascular risk factors among Malaysian adults. These include obesity, hypertension, diabetes and hypercholesterolemia(Teo et al. 1988 ; Ismail et al. 1995 ; Malaysia Institute for Public Health 1997). Among the Asia Pacific countries, the prevalence of overweight adults in Malaysia (BMI≥25.0kg/m^2) appears to be higher than that in Thailand, China and Japan but lower than for Australia and New Zealand(Khor 1997).

Vegetarianism has been associated with lower risks for hypertension, obesity, diabetes, diverticular disease, and cardiovascular disease as reviewed by Dwyer(1988) and Key et al.(1999). Vegetarians are on average thinner than comparable non-vegetarians(Key et al. 1998).

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A study on 1,900 vegetarians in Germany reported the mortality rate due to cardiovascular disease was 61% and 44% lower in male and female subjects respectively compared with the general population(Claude-Chang et al. 1992). Similarly, the Coronary Artery Risk Development in Young Adults(CARDIA) study of 5, 000 subjects aged between 18 – 30 years in California showed that mortality due to cardiovascular disease was lower in vegetarians than non-vegetarians(Slattery et al. 1991). Cardiovascular risk is lower in vegetarians in terms of lower blood pressures. The blood pressure lowering effect of vegetarian diets has been well documented, including studies of religious vegetarians such as Seventh-day Adventists(Beitlin 1994).

Epidemiological studies have also shown an association between a high vegetable intake and reduced risk of free radical-mediated degenerative diseases, such as epithelial cancers, cardiovascular disease and age-related eye diseases(Gey 1995 ; Ness & Powles 1997). In a study by Key et al.(1998) on 11,000 vegetarians and health conscious people in United Kingdom with a follow-up of about 17 years, they reported that daily consumption of fresh fruit was significantly associated with a reduced mortality from ischaemic heart disease. Krajcovicova-Kudlackova et al.(1995) found the molar ratio vitamin E/total lipids was significantly higher in plasma of vegetarians compared with non-vegetarians, demonstrating that vegetarians have more protection of polyunsaturated fatty acids against peroxidation. In summary, the studies mentioned above attributed dietary fibre, a rich variety of lignans and isoflavonoids, ascorbic acid, vitamin E and carotenoids in the vegetarian's diet as beneficial towards reducing cardiovascular and cancer risk.

In light of the above information, adoption of a healthy lifestyle that includes eating more vegetables and fruits would be desirable. Vegetarianism is practiced in Malaysia among followers of the Hindu and Buddhist faith. These comprise vegans who abstain from all animal products and lacto/ovo-vegetarians who include dairy products and/or eggs in their diet. Since cardiovascular disease is the leading cause of mortality in Malaysia, this study is aimed at providing some useful information on cardiovascular risk factors in a group of vegetarians.

Subjects and Methods

1. Population

The study subjects were members of the Malaysian Confucian Association, which has a large network of membership throughout the country. The total number of members in Kuala Lumpur is approximately 500. Letters of invitation to participate in this study were sent to members living in Kuala Lumpur area who were aged between 20 to 55 years and had been practicing vegetarians for at least one year. A total of 136 consented to participate in the study.

2. Data collection

The study was carried out between November 1998 and May 1999 and it included anthropometric measurements, taking of fasting blood samples, and interview using a structured questionnaire. Body weight was taken with light clothing using a digital weighing scale(Tanita model 1567), while the height was taken by means of a microtoise tape(Stanley-Mabo Besancon) suspended two meters from the floor. Waist and hip circumference were measured using a fibre glass tape. Waist circumference was taken at the mid point between the lower border of the rib cage and the iliac crest while hip circumference was measured at the widest part of the hip(WHO 1998).

Five milliliters of fasting blood was taken from each respondent for the determination of the following parameters : total cholesterol(TC), high density lipoprotein cholesterol(HDL-chol), total triglycerides(TG), retinol, total carotenoids, β-carotene and α-tocopherol. Serum TC and TG were determined by enzymatic kits based on the enzymic 'CHOD-PAP' and 'GPO-PAP' reactions respectively(Boehringer Mannheim)(Institute for Medical Research 1990). The Friedewald formula(1972) was used to estimate low density lipoprotein cholesterol (LDL-chol) concentration. The determination of retinol, total carotenoids, β-carotene and α-tocopherol concentrations by high pressure liquid chromatography is explained in Tee & Khor(1995).

Questions pertaining to the socio-economic background, smoking and alcohol consumption habits, exercise and family medical history were asked of the

respondents. Dietary intake pattern was gathered by using a food frequency questionnaire that comprised foods that are commonly consumed by Malaysians. The data collected were analyzed using the program Statistical Package for Social Science(SPSS® for Windows, SPSS Inc, Chicago, USA)

3. Classification of anthropometry and blood parameters

Body mass index(kg/m²)(WHO, 1998)		
<18.5	: Underweight	
18.5 - 24.9	: Normal range	
25.0 - 29.9	: Overweight, pre-obese	
≥30.0	: Obese	
Waist-hip ratio(WHO, 1998)		
>0.85(female) and >1.0(male)	: Risk of central obesity	
Blood pressure(WHO/ISH, 1999)		
Systolic blood pressure ≥140mmHg and/or diastolic blood pressure≥90mmHg	: Hypertension	
Blood lipids(IMR, 1990)	: Increased risk of hyperlipidaemia :	
Total cholesterol(TC)	>260mg/dl(> 6.7mmol/L)	
LDL-cholesterol(LDL-chol)	>190mg/dl(> 4.9mmol/L)	
HDL-cholesterol(HDL-chol)(male)	<35mg/dl(<0.9mmol/L)	
(female)	<43mg/dl(<1.2mmol/L)	
% HDL-chol	<15%	
Total triglycerides(TG)	>190mg/dl(> 2.1mmol/L)	
Serum retinol, carotenoids and α-tocopherol(Tee & Khor 1995)		
Retinol	<30μg/dl	: Low
	30 - 110μg/dl	: Acceptable
	>110μg/dl	: High
Total carotenoids	<50μg/dl	: Low
	50 - 330μg/dl	: Acceptable
	>330μg/dl	: High
β-carotene	<5μg/dl	: Low
	5 - 70μg/dl	: Acceptable
	>70μg/dl	: High
α-tocopherol	<800μg/dl	: Low
	800 - 2900μg/dl	: Acceptable
	>2900μg/dl	: High

Results

1. Socio-economic profile of respondents

Out of 136 respondents included in the study were 88 female(59%) and 56 male(41%)(Table 1). Their respective mean age is 33.0±9 and 33.7±9 years with a range of 21 - 55 years. The respondents have been practicing vegetarianism for a mean period of about 6 years with most of them(91.2%) as lacto/ovo vegetarians. Majority of the respondents have attended 7 - 12 years of schooling, with about an equal proportion of the men and women(15%) having attained university level education. Approximately 36% of the men and 14% of women are self-employed(e.g. own business, direct sales) while more than half of them(57% of men and 63% of women) are employed as teachers, and in managerial, professional and administrative positions. The mean income of the respondents is RM1,663 per month with more men(28.6%) than women(8.8%) earning more than RM2,000 per month.

2. Smoking, alcohol consumption, exercise and medical history

None of the respondents are smokers although 26.8% of the men had smoked previously and have stopped. Very few women have ever smoked(2.5%). More than half(57.1%) of the men reported not having taken alcoholic drinks before(beer, wine and distilled spirits). Approximately, two-thirds of the men and women said they exercise at least once a week, including brisk walking, swimming, bicycling, jogging and aerobic exercise.

Two of the respondents had experienced heart attack previously, while five have been diagnosed with hypertension. A significant proportion of the respondents have relatives(including parents, siblings, uncles and aunts) with hypertension(35.3%), diabetes(25%) and heart disease(11.8%).

3. Body mass index and waist hip ratio

The mean BMI for men and women are 22.5±2.4 kg/m² and 21.9±3.1kg/m² respectively(Table 2). The majority of the respondents have normal BMI values (80.4% men and 67.5% women). More women(13.6%) are underweight compared to men(5.4%), while the prevalence of obese is low(2.5% in women and none in men). By the WHR index, 10% of the women and none of the men showed risk of central obesity. The mean WHR value for men and women are 0.87±0.04 and 0.77±0.06 respectively.

4. Blood pressure

The mean systolic blood pressure for the men and the women are 122±16mmHg and 115±13mmHg, while their diastolic blood pressure are 82±7mmHg and 79±7mmHg respectively(Table 3). Hypertension was found at a higher prevalence among the men(17.6%) than women(7.1%).

5. Serum lipids

Average total cholesterol, HDL-cholesterol and LDL-cholesterol levels for the men are 4.27±0.77, 1.11±0.26 and 2.60±0.54mmol/L, while the corresponding values for the women are 4.24±0.81, 1.34±0.29 and 2.41±0.28mmol/L(Table 4). Values for these lipids at the 95% levels are within the normal limits. Only one female subject showed total cholesterol exceeding 6.7mmol/L while none of the subjects have high levels of LDL-cholesterol. However, 20.5% of the men and 39.1% of the women showed increased risk of low levels of HDL-cholesterol. Nonetheless, all the respondents showed percentage levels of HDL-cholesterol higher than the at-risk cut-off point of <15%.

6. Serum carotenoids and α-tocopherol

The mean values of serum retinol, β-carotene, total carotenoids and α-tocopherol for both men and women are within the acceptable levels(Table 5). Only a

Table 1. Characteristics of the study population by gender(%)

	Male(n=56)	Female(n=80)
Age(years)		
Mean±SD	33.0±8.9 years	33.7±9.4 years
20±34	64.3	55.0
35±44	21.4	27.5
45±55	14.3	17.5
Practising vegetarianism(years)		
Mean±SD	6.2±4.0 years	6.5±3.8 years
1±5	50.0	51.3
6±10	35.7	35.0
>10	14.3	13.8
Education level(years)		
Primary(1 - 6)	14.3	22.5
Secondary(7 - 12)	71.4	62.5
Tertiary(>12)	14.3	15.0
Occupational status		
Self-employed	35.7	13.8
Employee	57.1	62.5
Housewife	0.0	17.5
Others[1]	7.2	6.2
Gross monthly household income(RM)[2]		
Mean±SD	RM2234±RM1633	RM1263±RM695
<1000	14.3	48.8
1001±2000	57.1	42.5
2001±3000	12.5	7.5
>3000	16.1	1.3
Lifestyles : Smoking		
Never	73.2	97.5
Stopped	26.8	2.5
Consumption of alcoholic drinks		
Never	57.1	88.8
Stopped	42.9	11.2
Exercise regularly		
Never	35.7	32.5
At least once a week	64.3	67.5

[1]Students, disabled, retired, unemployed
[2]RM 3.80=US$1.00

Table 2. Anthropometric status of male and female subjects

	Mean±SD	5%	95%
Stature(cm)			
Male	167.5 ± 0.05***	154.9	176.2
Female	157.2 ± 0.06	146.1	168.0
Weight(kg)			
Male	63.3 ± 7.6***	48.9	75.0
Female	54.2 ± 8.6	42.3	69.9
Body mass index(BMI)(kg/m²)			
Male	22.5 ± 2.4	17.6	26.6
Female	21.9 ± 3.1	17.9	28.7
Waist circumference(mm)			
Male	828 ± 65***	709	929
Female	727 ± 81	621	894
Hip circumference(mm)			
Male	950±49	860	1025
Female	949±61	858	1050
Waist-hip ratio			
Male	0.87 ± 0.04***	0.79	0.93
Female	0.77 ± 0.06	0.68	0.86

	Male		Female	
	N	%	N	%
BMI(kg/m²)				
<18.5	3	5.4	11	13.6
18.5 - 24.9	45	80.4	54	67.5
25.0 - 29.9	8	14.3	13	16.3
>30.0	0	0.0	2	2.5
WHR				
<0.85	-	-	72	90.0
≥0.85	-	-	8	10.0
<1.0	56	100	-	-
≥1.0	0	0.0	-	-

Significant difference between gender at p<0.05*, <0.01**, <0.001***

Table 3. Blood pressure of male and female subjects

	Mean ± SD	5%	95%
Systolic blood pressure			
Male	121 ± 15.8*	98.8	161.6
Female	115 ± 12.6	97.1	140.9
Diastolic blood pressure			
Male	82.3 ± 7.0**	72.0	95.8
Female	78.6 ± 7.0	67.6	90.9

	Male		Female	
	N	%	N	%
Hypertension				
Systolic blood pressure 140mmHg and/or diastolic blood pressure ≥ 90mmHg	9	17.6	5	7.1

Significant difference between gender at $p<0.05$*, <0.01**, <0.001***

Table 4. Blood lipid profile by gender

	Mean ± SD	5%	95%
Total cholesterol(TC)(mmol/L)			
Male	4.27 ± 0.77	2.90	5.63
Female	4.24 ± 0.81	2.84	5.78
HDL cholesterol(mmol/L)			
Male	1.11 ± 0.26***	0.70	1.69
Female	1.34 ± 0.29	0.92	1.93
LDL cholesterol(mmol/L)			
Male	2.60 ± 0.54	1.60	3.43
Female	2.41 ± 0.78	0.96	3.98
HDL-cholesterol(%)			
Male	26.61 ± 7.02***	17.00	40.75
Female	33.02 ± 9.76	20.25	51.75
Total triglycerides(mmol/L)			
Male	1.17 ± 0.59	0.48	2.78
Female	0.97 ± 0.56	0.50	1.94

	Male		Female	
	N	%	N	%
Total cholesterol > 6.7mmol/L				
	0	0	1	1.4
HDL-cholesterol				
<0.9mmol/L	9	20.5	-	-
<1.2mmol/L	-	-	25	39.1
LDL-cholesterol > 4.9mmol/L				
	0	0	0	0
HDL-chol <15%				
	0	0	0	0
Total triglycerides > 2.1mmol/L				
	3	6.0	2	2.9

Significant difference between gender at $p<0.05$*, <0.01**, <0.001***

Table 5. Distribution of male and female subjects according to low, acceptable and high values for serum retinol, carotenoids and α-tocopherol

	Men(%)	Women(%)
Total carotenoids(μg/dl)		
<50	2.0	1.4
50 - 330	98.0	98.6
>330	0	0
β-carotene(μg/dl)		
<5	0	0
5 - 70	98.0	91.3
>70	2.0	8.7
Retinol(μg/dl)		
<30	0	2.9
30 - 110	100	97.1
>110	0	0
α-tocopherol(μg/dl)		
<800	26.0	21.7
800 - 2900	74.0	78.3
>2900	0	0

Table 6. Mean values and percentile distribution for serum retinol, carotenoids and α-tocopherol by gender

	Mean ± SD	5%	95%
Total carotenoids(μg/dl)			
Male	132.0 ± 57.2	54.5	236.6
Female	152.8 ± 59.2	57.1	268.4
Lutein(μg/dl)			
Male	54.4 ± 25.9	20.8	115.2
Female	61.1 ± 25.3	20.1	103.3
β-cryptoxanthin(μg/dl)			
Male	23.9 ± 15.3	8.0	61.8
Female	25.8 ± 13.4	7.8	54.5
β-carotene(μg/dl)			
Male	23.8 ± 15.8***	5.6	59.0
Female	35.7 ± 21.4	11.1	81.5
Lycopene(μg/dl)			
Male	11.1 ± 6.6	2.1	25.9
Female	10.9 ± 6.3	3.7	24.7
α-carotene(μg/dl)			
Male	7.0 ± 4.8	0.0	17.1
Female	5.4 ± 3.8	0.0	12.8
Retinol(μg/dl)			
Male	62.2 ± 15.1***	35.2	87.8
Female	51.1 ± 11.1	35.6	68.7
α-tocopherol(μg/dl)			
Male	1009.5 ± 340.0	496.9	1882.1
Female	1088.0 ± 393.6	655.5	2070.5

Significant difference between gender at $p<0.05$*, <0.01**, <0.001***

Table 7. Frequency of food intake

Item	Percentage of subjects				
	Daily	2 - 3 times a week	Once a week	Once a month	Seldom
Rice	94.1	5.9	-	-	-
Porridge	5.9	22.0	20.6	19.9	31.6
Bread	20.6	33.8	17.6	14.0	14.0
Noodle	12.5	41.9	30.1	7.4	8.1
Noodle, rice	7.4	33.8	36.0	16.9	5.9
Noodle, rice(flat)	2.2	16.9	26.5	26.5	27.9
Noodle, mungbean	0.7	1.5	7.4	11.8	78.7
Potato(Solanum tuberosum)	8.8	36.1	33.8	11.0	10.3
Sweet potato(Ipomoea batatas)	0.7	3.0	15.4	27.2	53.7
Tapioca(Manihot utilissima)	0.7	2.2	3.0	16.2	77.9
Taro(Colocasia esculentum)	0.7	3.0	8.1	29.4	58.8
Bean, string(Vigna sinensis)	7.4	33.0	33.1	18.4	8.1
Bean, French(Phaseolus vulgaris)	4.4	29.4	37.5	19.1	9.6
Peanut/Groundnut(Arachis hypogea)	5.9	24.2	32.4	27.2	10.3
Gram, red(Phaseolus angularis)	5.9	18.4	33.1	30.1	12.5
Gram, green/ Mung bean(Phaseolus aureus)	4.4	11.0	15.4	34.6	34.6
Lady's fingers(Hibiscus esculentus)	5.9	30.9	33.8	20.6	8.8
Soya bean(Glycine max)	14.0	27.2	24.2	18.4	16.2
Soya bean curd(soft)	8.1	55.1	28.0	5.9	2.9
Soya bean curd(fried)	1.5	22.8	27.9	22.8	25.0
Soya bean curd(firm)	8.8	42.7	25.7	18.4	4.4
Soya been curd(sheet/film)	6.6	23.5	30.9	19.9	19.1
Milk	19.9	18.3	16.2	12.5	33.1
Egg	4.4	36.8	24.2	14.7	19.9
Cabbage(Brassica oleracea)	6.6	24.3	30.9	18.3	19.9
Swamp cabbage(Ipomoea aquatica)	2.2	15.4	31.7	25.0	25.7
Spinach(Amaranthus viridis)	1.5	21.3	30.9	24.2	22.1
Broccoli(Brassica oleracea)	2.9	14.7	28.0	27.2	27.2
Kale, Chinese(Brassica alboglabra)	2.9	14.0	33.8	27.2	22.1
Cucumber(Cucumis sativus)	2.2	31.6	33.8	18.4	14.0
Mustard leaves, Chinese(Brassica juncea)	5.9	49.3	30.1	8.1	6.6
Cauliflower(Brassica oleracea)	2.2	28.7	36.8	17.6	14.7
Egg plant/Brinjal(Solanum melongena)	3.7	25.7	25.7	23.6	21.3
Tomato(Lycopersicum esculentum)	5.9	44.1	30.1	8.1	11.8
Carrot(Daucas carota)	22.1	52.2	13.2	7.4	5.1
Chives, Chinese(Allium odorum)	0.7	1.5	4.4	5.2	88.2
Mushroom, Chinese(Agaricus bretscheideri)	8.8	41.2	25.7	15.5	8.8
Seaweed	2.2	14.0	22.8	25.7	35.3
Yam bean(Pachyrrhizus erosus/P. bulbosus)	0.7	5.9	9.6	31.6	52.2
Mango(Mangifera indica)	0.7	3.0	5.1	26.5	64.7
Mangosteen(Gardinia mangostana)	0.7	-	-	7.4	91.9
Orange(Citrus nobilis)	8.1	44.1	27.9	14.0	5.9
Papaya(Carica papaya)	2.2	20.6	33.1	31.6	12.5
Guava(Psidium guajava)	2.2	11.0	19.1	33.1	34.6
Star fruit(Averrhoa carambola)	1.5	1.4	8.1	25.0	64.0
Apple(Pyrus malus)	14.0	33.8	24.3	25.0	2.9
Pineapple(Ananas comosa)	0.7	3.0	15.4	32.4	48.5
Watermelon(Citrullus vulgaris)	2.2	15.4	27.2	41.2	14.0

Table 7. Continued

Item	Percentage of subjects				
	Daily	2-3 times a week	Once a week	Once a month	Seldom
Banana(Musa sapientium/M. paradisiaca)	2.9	18.4	19.9	36.0	22.8
Rambutan(Nephelium lappaceum)	0.7	1.5	2.2	14.0	81.6
Meat analogue	12.5	39.7	22.8	13.2	11.8
Seafood analogue	4.4	17.7	23.5	18.4	36.0
Carbonated drinks	1.5	4.4	9.5	20.6	64.0
Coffee	11.0	12.5	13.2	9.6	53.7
Tea	15.4	25.0	11.1	17.6	30.9

Table 8. Anthropometry, blood pressure and fasting blood lipids according to age and gender

	Age(years)		t value
	20-44	45-55	
Body mass index(kg/m²)	Mean±SD		
Male	22.6 ± 2.4	22.1 ± 2.0	0.620
Female	21.4 ± 3.0	24.4 ± 2.5	3.932**
Waist-hip ratio			
Male	0.86± 0.05	0.90± 0.02	3.912***
Female	0.76± 0.06	0.82± 0.04	4.732***
Systolic blood pressure(mmHg)			
Male	118.7 ±13.3	136.5 ±19.7	2.449*
Female	114.5 ±13.0	121.6 ± 8.5	2.224*
Diastolic blood pressure(mmHg)			
Male	80.5 ± 5.9	90.1 ± 7.5	3.420**
Female	78.3 ± 7.6	81.0 ± 3.4	1.853
Total cholesterol(mmol/L)			
Male	4.2 ± 0.8	4.4 ± 0.5	0.614
Female	4.0 ± 0.6	4.6 ± 0.7	2.375*
HDL cholesterol(mmol/L)			
Male	1.1 ± 0.2	1.2 ± 0.2	0.967
Female	1.4 ± 0.3	1.2 ± 0.2	2.599*
LDL cholesterol(mmol/L)			
Male	2.6 ± 0.5	2.6 ± 0.6	0.039
Female	2.2 ± 0.6	2.8 ± 0.6	2.901*
Triglycerides(mmol/L)			
Male	1.1 ± 0.5	1.4 ± 0.7	1.368
Female	0.9 ± 0.6	1.1 ± 0.3	1.394

* : $p<0.05$; ** : $p<0.01$; *** : $p<0.001$

small percentage of the subjects has a low level of serum retinol and total carotenoids, while none showed a low serum β-carotene level. Most of them have levels of serum retinol, carotenoids and α-tocopherol that lie within the acceptable range. In the case α-tocopherol, 26% and 21.7% of the men and women respectively showed low levels.

Among the carotenoids, lutein constitutes the major component(about 40% of the total carotenoids for men and women)(Table 6). The next abundant carotenoids are β-cryptoxanthin and β-carotene each contributing to 18-24%, while lycopene and α-carotene together made up 11-14% of the total carotenoids.

7. Food intake pattern

Rice is the staple food of Malaysians and it is taken daily by almost all the subjects(Table 7). Other carbohydrate foods consumed by the majority at least once a week include bread, various types of noodles (made from rice and wheat flour) and root tubers. The subjects consume soya bean in various forms as soft curd, fried "tau kua" and in sheet form "fu chok". A wide variety of vegetables are eaten. These include mustard green, cabbage, cucumber, tomato, carrot, mushroom and spinach. These vegetables are consumed by a significant number of the respondents at least 2-3 times a week. As for fruits, the subjects consume frequently both imported fruits such as oranges and apples, and Malaysian grown fruits like papaya, mango, star fruits, watermelon and many varieties of banana. Meat and seafood analogues are also popular as more than half of the vegetarians consumed these foods at least once a week. The most preferred beverage is Chinese tea.

Discussion

The vegetarian subjects in this study from urban areas have a relatively low mean BMI and WHR levels in general. Their mean BMI values($22.5\pm2.4kg/m^2$ and $21.9\pm3.1kg/m^2$ for males and females respectively) are comparable with the average levels of subjects from poor rural communities($22.5\pm3.9kg/m^2$ in males and $23.8\pm4.9kg/m^2$ in females)(Khor et al. 1999). When

compared with urban subjects, the vegetarians have a lower prevalence of overweight. In urban adults, overweight(BMI between 25.0 and 29.9kg/m^2) prevalence of 24% and 18.1% in males and females respectively was reported(Ismail et al. 1995), compared with the corresponding prevalence of 14.3% and 16.3% among the vegetarians. Overweight has emerged as a matter of public health concern in Malaysia. A large-scale nation-wide survey(Second National Health and Morbidity Survey)(NHMSII) had reported the prevalence of overweight(BMI$>$25.0kg/m^2) in urban subjects as 17.4%(Public Health Institute 1997).

The mean total cholesterol values of both male and female vegetarians are lower than those of rural subjects(Ng et al. 2000). When compared with urban subjects, the vegetarian subjects showed a lower prevalence of hypercholesterolmia. In the study of Teo et al.(1988), 30.8% of 406 urban office workers aged 25 – 51 years showed TC levels above 6.5 mmol/L while only one respondent(0.8%) in the present study who exceeded that level. Likewise, the previous study had reported 28.2% with % HDL-chol $<$15% compared with none in the present study.

Age has a significant influence on several of the cardiovascular risk factors especially in women. Increase in age between the 20 – 44 and 45 – 55 age groups significantly increases the mean BMI, WHR, systolic and diastolic blood pressure, total cholesterol and LDL-cholesterol and lowers the HDL-cholesterol among the women(Table 8). In men, their BMI, WHR and blood pressure also showed significant increase with age.

Another cardiovascular risk factor found low among the vegetarians is smoking. In fact none of the respondents reported smoking at the time of the study. In contrast, the NHMSII(Public Health Institute, 1997) had reported a prevalence of current smoking as 24.8% (19.2% among the Chinese). The prevalence of hypertension among the vegetarians(10.3% male and female combined) is low when compared with the overall NHMSII prevalence of 29.9%.

The usual intake data showed the respondents habitually consume a diet that comprises a diversity of plant foods. Very few of the respondents showed a low serum level of any of the carotenoids analyzed. Compared with the blood antioxidant result of healthy non-smoking adult Dutch subjects on a high-vegetable diet(490g/day) for 4 weeks(van het Hof et al. 1999), this study recorded even higher mean levels of serum retinol(2.18 and 1.79μmol/L male and female respectively), β-carotene(0.43μmol/L male and 0.64μmol/L female) and α-tocopherol(23.5 and 25.3μmol/L male and female respectively). The mean levels of these antioxidants in the Dutch study were respectively 1.67, 0.37 and 8.4μmol/L(sexes combined).

Besides β-carotene, a high consumption of vegetables also contributes other carotenoids such as lutein that has been implicated with age-related macular degeneration(van het Hof et al. 1999). In this study, serum lutein was found highest among the carotenoids in the subjects, reflecting the fact that lutein is the major type of carotenoids in vegetables.

Negative effects from the consumption of certain plant constituents are known. Phytates and polyphenolics can inhibit non-heme iron absorption, leading to low iron stores. Studies have shown that vegetarians are more likely to be at risk of iron, vitamin B_{12} and zinc deficiency(Ball & Bartlett 1999 ; Li et al. 2000). It is thus important for vegetarians to maintain an adequate iron status and follow dietary practices that enhance iron absorption, as exemplified by a diet that is high in vitamin C-rich fruits and vegetables as well as containing a variety of whole grains, legumes, nuts and seeds that are rich in iron(Craig 1994).

There is also concern for calcium adequacy among Asian vegetarians including lacto-vegetarians, in light of low intake of dairy products among Asians in general. Also, diets that contain high concentrations of oxalates or phytake, as is likely for vegans, may reduce calcium absorption sufficiently to offset a decrease in calcium losses of a low-protein diet(Weaver & Plawecki 1994). Compared with vegans, lacto-vegetarians are more likely to meet the recommended dietary calcium level and as such they do not seem to be at increased risk of for developing osteoporosis. Nonetheless, a study on Chinese elderly women found no significant difference in bone mineral density between vegans and lactovegetarians (Lau et al. 1998). Little information is available on the relationship between the intake of various nutrients and bone mineral density in Asian subjects.

■ **Acknowlegement**

Sincere appreciation is extended to members of the Malaysian Confucian Associations in Kuala Lumpur and Klang for their close cooperation in this study. The assistance of my colleague, Dr Long Seh Chin, in taking blood from the respondents is gratefully acknowledged. Much appreciation is also expressed to Khor Swan Choo of IMR for analyzing the blood samples, Voon Phaik Choo for data collection and Cheong Mei Leng for data analysis. The authors are grateful to PORIM for its financial support.

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