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Nutritional status of elderly Chinese vegetarians

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Abstract

Aim: to study the nutritional status of elderly Chinese vegetarians.
Subjects and method: dietary intake (using the 24-h recall method), anthropometric indices and some nutritional laboratory parameters were studied in 131 elderly Chinese vegetarian women with a mean age of 81 years. Data from age- and sex-matched omnivore subjects from previous elderly surveys were used for comparison.
Results: total energy, fat and protein calorie, thiamine, riboflavin and niacin intakes were lower in vegetarians than in non-vegetarians, while carbohydrate calorie, calcium, potassium, retinol equivalent and ascorbic acid intakes were higher. The 25th, 50th and 75th percentile for total body fat were lower and those for corrected arm muscle area were higher in vegetarians. Both urinary Na/Cr and K/Cr ratios were higher but the Na/K ratio was similar to that in non-vegetarians, as were mean systolic and diastolic blood pressures. Serum total cholesterol was lower, while serum triglyceride concentration was similar. The mean haemoglobin level was lower in vegetarians, the prevalence of anaemia being 30%, with deficiencies in B12 and/or iron accounting for 64% of the anaemia, compared with only 30% in non-vegetarians. Serum B12 concentration below the reference range occurred in 54% of the vegetarian subjects. Vegetarians also had a lower prevalence of a history of ischaemic heart disease; however, the prevalence of smoking was also lower.
Conclusion: while the Chinese vegetarian diet may result in a favourable risk-factor profile for ischaemic heart disease, it is deficient in many B vitamins and gives rise to a high frequency of nutritional anaemias.

Keywords: *anaemia, China, vegetarian, vitamin B*

Introduction

The study of nutritional status of elderly people is of particular importance, as they are at greater risk of malnutrition [1] and at the same time have an increased prevalence of many chronic diseases which may be associated with nutritional status [2, 3]. There are few studies of the nutritional status of elderly vegetarians. In general, although the dietary intake in vegetarians appears favourable with respect to chronic disease risk-factor profile, deficiencies in certain nutrients have been documented [4–9]. Of the published studies, all have been carried out in Caucasian populations, with very few in elderly subjects [10]. When elderly subjects were studied, the mean age was below 70 years and biochemical data were not available. There is little information in the very old, who may be at greater risk for nutritional deficiencies, and no information on Chinese populations.

Since the traditional Chinese diet is different from Caucasian ones and vegetarianism is not uncommon (particularly among elderly subjects) as it is linked to certain religious practices, documentation of the nutritional status of this group is important. Although the absolute number of vegetarians may not be great in the Hong Kong Chinese population, it is important to study their nutritional status, as certain religious organizations of which members are vegetarians run social centres and residential homes for the elderly where only vegetarian meals are served. Moreover, the Hong Kong Chinese elderly population have prevalences of chronic medical conditions comparable to those in older Caucasians [11, 12], and it would be of interest to determine whether the practice of vegetarianism forms part of a 'healthy' lifestyle, reducing the susceptibility to these diseases.

In this study, we examined the dietary intake, anthropometric indices and some haematological and biochemical parameters in a group of elderly Chinese vegetarian women and compared the results with data obtained from previous nutritional studies of the general elderly Chinese population.

Subjects and methods

The vegetarians were recruited from members of religious organizations on a voluntary basis after one of the authors visited to give health talks. The study consisted of two parts: a dietary assessment and measurement of anthropometry, blood pressure, blood and urine sampling. One hundred and thirty-one subjects volunteered for the dietary assessment; of these, 106 agreed to come to the hospital for the other part of the study. As there were very few men, only women were studied. All were older than 65, had been vegetarian for over 10 years and were fit and ambulant. The group included both vegans and lacto-ovo-vegetarians.

Dietary assessment was carried out either at the hospital or at the subject's place of residence and the 24-h recall method was used. This method was chosen to facilitate comparison with the results of a previous survey of elderly Chinese subjects which had employed the same method of assessment [13]. The dietary assessment was administered by trained interviewers; all food items consumed and the portion size over a typical 24 h period were recorded and the quantity of nutrients was calculated using food composition tables appropriate for this area [14].

Those subjects who agreed to attend the hospital were also asked whether they had a history of ischaemic heart disease, hypertension or diabetes. Blood pressure was measured using a standard mercury sphygmomanometer. Height and weight were measured in indoor clothing without shoes, using a standard scale with height measurement attachment. Arm circumference was measured at the mid-point between the acromion and olecranon processes and biceps and triceps skin-fold thicknesses were measured with Holtain callipers at the same point. The average of two readings was used.

Body mass index was calculated as weight (kg) divided by height (m^2). Total body fat was calculated according to Durnin and Womersley [15] as:

$$\left[\frac{4.95}{(c-m)\times \log \text{ skin-fold}} - 4.50\right] \times \text{ body weight}$$

where c and m are regression equation constants for the estimation of body density from the logarithm of skin-fold thickness (1.1226 and 0.0710 respectively for women); log skin-fold is log (biceps + triceps skin-fold thickness in mm).

Fat-free mass was calculated [15] from (body weight - total body fat).

Arm muscle circumference (AMC) was derived from the equation:

$$\text{AMC (cm)} = \text{arm circumference (cm)} - \frac{[\pi \times \text{triceps skin-fold thickness (mm)}]}{10}$$

Corrected arm muscle area (CAMA), a measurement of important prognostic value for severe wasting malnutrition in elderly subjects [16], was calculated using the equation:

$$\text{CAMA (cm)}^2 = \frac{(\text{AMC})^2}{4\pi} - 6.5$$

for women [17].

Results are presented in percentile values.

Laboratory values measured included haemoglobin and mean corpuscular volume, serum cobalamin, serum iron, total iron binding capacity, serum folate, fasting serum total cholesterol and triglyceride concentrations and random urine sodium, potassium and creatinine, using standard laboratory methods. Urinary variables were measured as they provide an approximate indication of dietary sodium and potassium intake and have been shown to be associated with blood pressure [18]. Approval from the clinical research ethics committee was obtained.

Comparable data for elderly female Chinese omnivores of the same age groups were obtained from multiple sources: a health and nutrition survey of elderly Hong Kong Chinese ambulant, community-living subjects [13] and, for data on cholesterol and triglycerides, a survey of 53 elderly women aged 70–79 years attending various social centres [19]. Data from a health and social survey of elderly Chinese aged 70 years and over [11] were used for comparison of the self-reported prevalences of heart disease, hypertension and diabetes.

The first survey consisted of a cohort of residents aged 60 years and over living in an estate close to the hospital, where the response rate was 96%. Dietary assessment was available in 250 out of 256 women. The mean age of the cohort was 70.7 ± 4.7 years. No difference in nutrient quantity was observed between those <70 years of age and those ⩾70 years. Neither were age-related changes in haemoglobin values observed in this cohort. Urinary specimens were obtained from 166 of the cohort [20].

The second survey consisted of subjects recruited as controls for a case-control study on cerebrovascular disease risk factors in Hong Kong Chinese. The third survey was a random sampling of the Hong Kong Chinese population aged 70 years and over, stratified by sex and 5-year age group.

The Student's t test was used to compare mean values between vegetarians and omnivores and χ^2 test for categorical variables.

Results

The mean age of the vegetarian women was 81.3 ± 7.6 years and the median duration of the dietary practice was 25 years. The prevalence of chronic medical diseases and smoking habit are shown in Table 1.

Table 1. History of chronic medical conditions and smoking habit

	No. (and %), by diet and age (years)			
	Vegetarian		Omnivore[a]	
	70-79 (n = 56)	≥80 (n = 53)	70-79 (n = 62)	≥80 (n = 39)
Ischaemic heart disease	5 (9)[b]	8 (15)	15 (24)	5 (13)
Hypertension	15 (27)	9 (17)	27 (44)	8 (13)
Diabetes	3 (5)	5 (9)	9 (15)	5 (13)
Smoker (current + ex)	2 (4)[c]	6 (11)	16 (26)	7 (18)

[a]Data from Ho and Woo (1994) [11].
χ^2 test between vegetarians and omnivores of the same age group: [b]$P < 0.05$; [c]$P < 0.01$.

Vegetarians aged 70-79 reported a lower frequency of ischaemic heart disease compared with omnivores; at the same time the prevalence of smoking was also lower. No other significant differences were observed.

Table 2 compares the intake of nutrient quantities between vegetarians and omnivores. Total energy, fat and protein calorie, thiamine, riboflavin and niacin intake were lower in vegetarians. Carbohydrate calorie, calcium, potassium, retinol equivalent and ascorbic acid intakes were higher.

The 25th, 50th and 75th percentiles for anthropometric indices are shown in Table 3. The percentiles for total body fat are lower in vegetarians than omnivores while the corrected arm muscle area is higher in vegetarians. Vegetarians had lower mean serum total cholesterol concentration than omnivores (Table 4). The mean urinary Na/Cr and K/Cr values were both higher in vegetarians, possibly reflecting higher sodium and potassium intakes. However, the mean Na/K ratios were similar, as were mean blood pressures. The mean haemoglobin concentration was lower in vegetarians, with a greater number (30%) having values <12 g/dl, the World Health Organisation criteria of anaemia for women [23].

The contributions of B12, iron and folate deficiency to the anaemia are shown in Table 5. Deficiencies in these nutrients account for 64% of anaemia in vegetarians, compared with 30% in omnivores. Eight

Table 2. Dietary intake of vegetarian women compared with non-vegetarians

	Mean value (SD), by diet	
	Vegetarian (n = 179)	Omnivore (n = 250)[a] [13]
Age (years)	81.3 (7.6)[c]	70.7 (4.7)
Energy (kcal)	1093 (347)[d]	1557 (510)
Proportion of calories (%)		
Carbohydrate	75 (8)[d]	64 (12)
Protein	12 (3)[d]	16 (5)
Fat	14 (8)[d]	19 (12)
Per 1000 kcal		
Calcium (mg)	328 (193)[d]	221 (168)
Potassium (mg)	914 (397)[b]	783 (449)
Iron (mg)	8.5 (2.3)	8.3 (4.5)
Retinol equivalent (μg)	456 (294)[b]	407 (33)
Thiamine (mg)	0.38 (0.15)[d]	0.60 (0.32)
Riboflavin (mg)	0.38 (0.10)[d]	0.45 (0.20)
Niacin (mg)	4.94 (2.97)[d]	7.44 (3.26)
Ascorbic acid (mg)	102 (61)[b]	84 (54)

[a]Data from Woo (1988) [13].
Student's t test: [b]$P < 0.01$; [c]$P < 0.005$; [d]$P < 0.0001$.

Table 3. Anthropometric indices

	Percentile value		
	25th	50th	75th
Body mass index (kg/m^2)			
Vegetarian	20.4	22.5	25.1
Omnivore[a]	20.7	22.3	25.2
Fat-free mass (kg)			
Vegetarian	29.9	34.5	36.0
Omnivore	30.1	33.3	36.2
Total body fat (kg)			
Vegetarian	10.8	14.6	17.6
Omnivore	12.9	16.7	20.4
Arm muscle circumference (cm)			
Vegetarian	20.0	21.1	22.2
Omnivore	19.1	20.4	21.9
Corrected arm muscle area (cm^2)			
Vegetarian	25.5	28.8	32.8
Omnivore	22.5	26.6	31.5

[a]Data from Woo *et al.* (1988) [21]; age range: 75–90 years; (n = 42).

of the vegetarian subjects had haemoglobin values <10 and in six this was due to nutrient deficiencies: three had B12 deficiency, two had combined B12 and iron deficiencies and one had iron deficiency. The prevalence of iron deficiency appears similar in vegetarians and omnivores, the most striking difference being the high prevalence of B12 deficiency among vegetarians, accounting for approximately 50% of anaemias. The prevalence of low serum B12 was greater than that of anaemia, occurring in 57 (53.8%) of the vegetarian subjects.

Discussion

Dietary assessment by the 24-h recall method may not be as accurate as weighed dietary records, since elderly

Table 4. Blood pressure and laboratory values

	Vegetarian		Omnivore	
	Mean (SD)	n	Mean (SD)	n
Haemoglobin				
Concentration (g/dl)	12.3 (1.4)[d]	106	13.4(1.1)	228[a]
No. (and %) < 12 g/dl	33 (30.3)[e]		23 (10.1)	
Total cholesterol (mmol/l)	4.8 (1.1)[d]	106	5.9 (1.2)	53[b]
Triglycerides (mmol/l)	1.58 (1.34)	106	1.68 (1.19)	53
Urinary ratio (mmol/mmol)				
Na/Cr	30.3(22.2)[d]	106	17.5 (4.3)	166[c]
K/Cr	7.7 (4.2)[d]	106	4.3 (4.5)	166
Na/K	4.3 (2.8)	106	4.2 (2.2)	166
Blood pressure (mmHg)				
Systolic	150 ± 27	106	143 ± 24	168[c]
Diastolic	76 ± 12	106	79 ± 12	168

[a]Data from Woo *et al.* (1989) [22]; mean age 70.7 ± 4.7 years.
[b]Data from Woo and Lam (1990) [19]; age 29–70 years.
[c]Data from Woo *et al.* (1988) [20]; mean age 70.7 ± 4.7 years.
[d]Student's t test: $P < 0.001$.
[e]χ^2 test: $P < 0.001$.

Table 5. Prevalence of nutritional deficiency as cause of anaemia[a]

	Number (and %) of subjects	
Deficiency	Vegetarian ($n = 33$)	Omnivore[b] ($n = 23$)
B12	16 (48.5)	1 (4.3)
Iron	2 (6.1)	5 (21.7)
Mixed iron and B12	3 (9.1)	0
Folate	0 (0)	1 (4.3)
None of the above	12 (36.4)	16 (69.6)

[a] Haemoglobin <12 g/dl.
[b]Data from Woo *et al.* (1987) [24]; mean age 70.7 ± 4.7 years.
Definitions of deficiency: B12 <150 pmol/l; iron saturation <10% (SeFe/TIBC); folate <2.1 μg/l.

subjects may have short-term memory impairment and day-to-day variations would not be taken into account. A 3-day food history may also be more accurate. Nevertheless the 24-h recall method had been used in several population surveys and is a useful method if mean intakes between different populations are to be compared. One of the few studies in elderly Caucasian vegetarians also employed this method [10].

The elderly Chinese population used for comparison [13] is a slightly younger one, with a mean age of 71 years compared with 81 years for the vegetarian women. However, the results from this cohort were similar to those from another survey of elderly community-living subjects aged 70 years and above using the same methods [25]. Data from the survey of the slightly younger cohort were used since anthropometric, blood and urine values were available.

Although the calculation of total body fat and fat-free mass was developed in Caucasian populations [13], calculated values correlated closely with measured values in elderly Chinese women using the Hologic QDR-2000 bone densitometer, which also provides body composition values (T. Kwok *et al.*, unpublished results). Since anthropometry and certain laboratory values are associated with the presence of chronic diseases (e.g. cardiovascular diseases), it is of interest to document these values in vegetarians. These associations include plasma lipid profile with ischaemic heart diseases, spot urinary electrolytes with hypertension [26, 27] and body mass index/body fat level with diabetes mellitus.

The prevalences of three diseases (by self-report) were similar between vegetarians and omnivores aged 80 years and above, but appeared to be lower in vegetarians for those aged 70–79 years, although statistical significance was reached only for ischaemic heart disease. However, this group also had fewer smokers, so that the lower prevalence may not be related to the vegetarian diet. Nevertheless, the lower intake of dietary fat and higher intake of carbohydrate would be favourable to the reduction of coronary heart disease risk.

A previous prospective study in British vegetarians showed that mortality from ischaemic heart disease was significantly lower in vegetarians after a 10–12-year follow-up, and a subset showed lower serum cholesterol and body mass index in the vegetarians [3]. The better lipid profile in vegetarians has also been documented elsewhere [28]. Elderly Chinese vegetarians also had lower serum cholesterol and, although the body mass index was similar to that of non-vegetarians, the total body fat was lower. In the UK study, no difference in blood pressure was found between the two groups. No blood pressure difference was observed in the present study, compatible with the finding of similar Na/K ratios between vegetarians and non-vegetarians. It appears that the higher Na/Cr ratio in Chinese vegetarians, which may predispose to hypertension [20], is counter-balanced by high K/Cr ratio, which may reduce blood pressure [30].

Although the elderly Chinese vegetarian diet appears to be beneficial with respect to prevention of chronic diseases, it is deficient in the B group of vitamins. This finding differs from surveys of elderly Caucasian vegetarian women which showed a higher nutrient density for thiamine [10]. The findings of higher retinol equivalent, ascorbic acid and lower fat intake are similar to this study. A 24-h recall method was also used, but the mean age of the subjects was younger (66.6 ± 10 years). Calcium intake among Caucasian vegetarians was also found to be higher than in the general Caucasian population. No difference in total energy intake was observed between vegetarians and omnivores. Vitamin B12 status was not described for this group of elderly Caucasian women, as dietary intake estimation is unreliable.

In another study of 50 Caucasian vegetarians with a mean age of 26 years (women) and 28 years (men), with a mean duration of vegetarian practice of 6 years and age- and sex-matched controls, protein intake was also found to be lower. The striking finding was reduced B12 intake, serum B12 concentration and serum ferritin (despite a higher iron intake) among vegetarians. Thirty-five percent of the subjects had serum B12 concentration below the reference range. In this study, over 50% of the elderly Chinese vegetarians had serum B12 concentrations below the reference range; however, the iron intakes were similar and the prevalence of iron deficiency anaemia was comparable to that in the general elderly population.

In addition to the higher mean age of the present study subjects, the difference in findings in our study may also be due to differences in the types of foods consumed by elderly Chinese vegetarians. One main difference between the diets of Caucasian and Chinese vegetarians is the Chinese group's greater consumption of rice and soya-bean products. Many vegetarian dishes

are based on soya beans. The greater consumption of soya-bean products and dark green vegetables may account for the higher calcium intake in vegetarians compared with the general population. It is interesting that absorption of calcium from some Chinese vegetables appears to be as good as from dairy products [31]. It would be of interest to compare the bone mineral density of elderly Chinese vegetarians and omnivores, in view of the higher calcium intake, although no difference has been documented in elderly Caucasian vegetarians [32]. Soya-bean products may also produce a lipid-lowering effect [33]. However, the oxalic acid content of soya beans is reported to be high and this may interfere with calcium absorption.

In elderly Chinese people, the vegetarian diet may be beneficial in terms of reducing the risk of coronary heart disease, but it is deficient in many B vitamins and forms an important cause of anaemia. Dietary supplementation with these vitamins may be indicated for elderly Chinese vegetarians.

Key points

- The dietary intake of elderly Chinese vegetarians is lower in total energy, fat and protein calories and many B vitamins than that of comparable non-vegetarians, but is higher in carbohydrate, vitamin C and calcium.
- Although some aspects of the dietary intake profile may be favourable for cardiovascular health, there is a high prevalence of nutritional anaemia (30%), mainly due to B12 deficiency.

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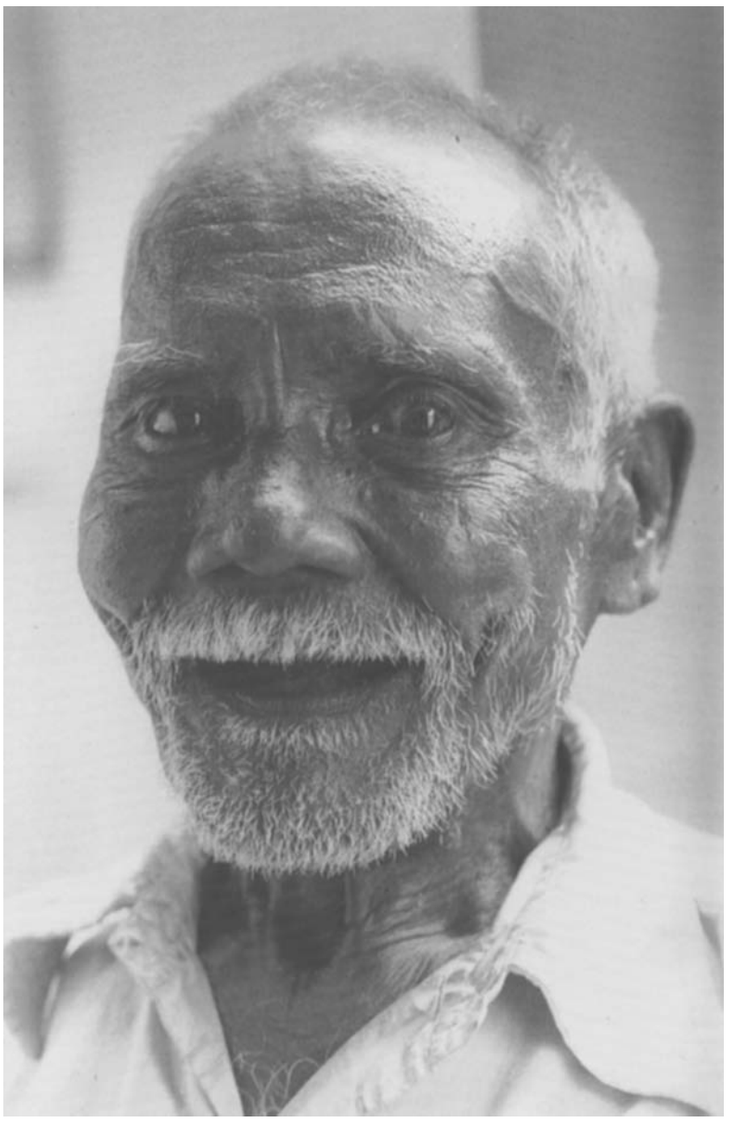

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