Hindawi Publishing Corporation
ISRN Geriatrics
Volume 2013, Article ID 564342, 9 pages
http://dx.doi.org/10.1155/2013/564342

Research Article

Assessment of Malnutrition in Community Chinese Elderly: A Hidden Problem in a Developed Society

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Received 8 August 2012; Accepted 29 August 2012

Academic Editors: D. Chan and O. Weinreb

Background. Malnutrition can lead to chronic disease especially in vulnerable population. This study is to explore the extent of the malnutrition problem in community Chinese elderly and its associating factors in Hong Kong. *Method*. This is a cross-sectional study using structured interview with 7-day food frequency questionnaires. 1960 men and 1954 women aged 65 or above were recruited from the community. *Results*. Less than half of the participants fulfilled the recommended intake level of the others. Less than 10% of participants met the daily requirement of fibre, Calcium, Vitamin D, Iodine, and Copper. 22.32% of male participants and 6.21% of female participants have cholesterol intake exceeding the recommended upper level. 41.19% men and 28.99% women exceeded the upper level of fat percentage of total energy. Educational level was demonstrated to have a consistent positive association with the adequate intake in most nutrients. Single or divorced marital status is a risk factor in over-intake of saturated fatty acid in men and under-intake in Zinc and meat in women. *Conclusion*. Our study has shown the serious malnutrition problem in a wide range of nutrients in community Chinese elderly in Hong Kong.

1. Introduction

Nutrition is vital for healthy ageing. Inappropriate diet is associated with different illnesses such as cancer, stroke, ischaemic heart disease, diabetic mellitus, and osteoporosis irrespective of the sex and ethnicity [1]. Previous studies have shown that the Mediterranean diet helped to reduce risk of cancer, which suggested that increasing fruit and vegetable consumption and decreasing meat intake would have a protective effect against cancer [2]. Another study also showed a strong protective effect of fibre, Vitamin C, and carotene as well as positive association between dietary fat intake and breast cancer amongst the Chinese [3]. A systematic review showed that diets with nonhydrogenated unsaturated fat, as the major forms of fat intake, whole grain, as the major form of carbohydrate along with high intake of fruits and vegetables, as well as adequate omega-3 fatty acid had a significant protection effect against cardiovascular diseases [4]. Another study in China showed that hyperlipidemia was positively associated with total energy, total fat, and saturated fatty acid intake and negatively associated with fibre intake [5]. A previous local study in Hong Kong found reduced mortality with increased fish uptake [6]. Inappropriate nutrient intake is not only confined to developing countries, but is also common amongst elderly in high income countries [7]. It is a global health issue closely related to socioeconomic transition and social disparity [7, 8]. Both over- and undernutrition can exist at the same time in the same country among different socioeconomic classes [7, 8]. This leads to differentials in mortality and morbidity in a population especially in the vulnerable groups such as elderly.

Although the importance of an appropriate diet is well documented, the prevalence of poor nutrition including a detailed account of specific nutrient intake is not well described in Chinese elderly populations. Appropriate health education and policies cannot be formulated without this

important information. Such studies as have been carried out have found variable results. For example, a small survey done in Singapore showed that elderly do not conform to healthy eating guidelines for the major food categories [9]. The only study assessing the protein intake of elderly people in a lower socioeconomic group in Hong Kong was done 20 years ago [10].

Thus, this study was to assess the health need in elderly people by documenting the extent of the malnutrition problem in a community of Chinese elderly and study the associated factors in Hong Kong.

2. Materials and Methods

2.1. Study Design and Participants. Two thousand men and two thousand women aged 65 or above were invited from the community by self-referral in health talks and posting recruitment notice in community centers for the elderly and housing estates in Hong Kong. All participants are Chinese and community dwelling. They were recruited and followed up for 5 years with questionnaires and health checks including blood taking, blood pressure monitoring, cognitive function assessment, and bone density measurement.

2.2. Measurements. Sociodemographics including age, educational level, marital status, and medical history were recorded by structured questionnaires administered by trained staff. Socioeconomic status was measured by a self-rated 10-point ladder scale. Their body mass index (BMI) was measured.

Dietary intake was assessed by a 7-day food frequency questionnaire with mean nutrients per day calculated using the table derived from McCance and Widdowson and the Chinese Medical Science Institute [11, 12]. The food frequency questionnaire consisted of seven categories of food items including bread/pasta/rice, vegetables, fruits, meat, beverages, dimsum/snacks, soups, and oil/salt/sauce. Food items in each category were chosen based on the Chinese diet in the Hong Kong population. Methods of cooking were also recorded. Since a previous study had found that variation between seasons was not a significant factor, we conducted interviews throughout the year regardless of the season [13]. Nutrients and food items of interest are Vitamin A, Vitamin B1, B2, and B3, Vitamin C, Vitamin D, Calcium, Phosphorus, Iron, Zinc, Iodine, Copper, protein, carbohydrate, fruit, vegetable, meat, fibre, cholesterol, fat percentage of total energy, saturated fatty acid, monosaturated fatty acid and polyunsaturated fatty acid, and total energy.

The subjects were asked to fill in the food items consumed, portion size, and number of times consumed per day, per week, or per year for less frequently consumed items. Portion size was explained to the participants by pictures and photographs. The amount of oil used in cooking is estimated by the formula used in another local study depending on the method of cooking: 0.2 tablespoon (tbsp) for steaming fish or stir frying half a portion of vegetables; 1 tbsp for stir frying one portion of meat or one portion of vegetables [14]. Validity of this food frequency questionnaire was validated by comparing the 24-hour intake of total energy, lipid, sodium, and potassium, with estimated values of total energy expenditure, plasma lipid level, and 24-hour urinary sodium, and potassium outputs. There were no significant differences observed in energy intake but there was an underestimation of sodium and potassium. The lipid intake is highly associated with the plasma lipid level [14].

2.3. Statistical Analysis. The mean dietary intake of each nutrient was calculated and compared with the intake level recommended by Department of Health, Hong Kong, and we have used the United States recommended levels when local standards were not available. The percentage of participants under or exceeding the recommended level was calculated. The adjusted odds ratio by multiple logistic regression was used to identify the nutritional risk factor of various sociodemographics and BMI of our subjects in different nutrients.

3. Results

One thousand nine hundred and sixty men and one thousand nine hundred and fifty four women aged 65 or above were recruited from the community. Their mean BMI was not significantly different from the Hong Kong population average in this age group (23 kg/m^2). The characteristics were shown in Table 1. The mean nutrient intakes of the subjects were shown in Tables 2 and 3. Most participants met the recommended requirement of Vitamin A; Vitamin C, Phosphorus, Iron, protein, and carbohydrate. There was no significant difference in men and women. A small percentage of participants exceeded the upper recommended level, most commonly for Vitamin A for which 3.3% of men and 2.3% of women exceeded the upper intake level of 3000 μg.

Less than half of the participants fulfilled the recommended intake level of the other nutrients. The most serious ones were Vitamin D, Iodine, and Copper for which none of the participants met the recommended daily intake. Moreover, less than 5% of subjects have taken enough Calcium and less than 10% of participants met the daily requirement of fibre. Less than half of the participants met the recommended daily intake of the following nutrients: Vitamin B1, Vitamin B2, Vitamin B3, Zinc, fruit, vegetable, and meat. These findings show that in most cases, more elderly women are undernourished than men.

Vitamin B3 intake showed the greatest variation, and despite less than half of the participants reaching the recommended level, up to 10% of subjects exceeded the upper recommended level (12.66% in men and 6.01% in women).

Fat intake was also suboptimal. Hong Kong elderly overconsumed fat. The situation in men is worse than in women. 22.32% of male participants and 6.21% of female participants had cholesterol intakes exceeding the recommended upper level. 41.19% men and 28.99% women exceeded the upper level of fat as a percentage of total energy. The picture is better for saturated fatty acid as a percentage of total energy. Only 5.11% of men and 2.4% of women exceeded the upper recommended level.

Logistic regression analysis of socioeconomic factors such as age, socioeconomic status, educational level, marital

Table 1: Characteristics of subjects.

Variable	Mean (SD)/Frequency (%)		P value*
	Female	Male	
Age	72.58 (5.36)	72.39 (5.01)	0.2541
Social economic ladder of Hong Kong	4.64 (1.92)	4.45 (1.87)	0.0020
Education level			<0.0001
No education	753 (37.65%)	103 (5.15%)	
Primary or below	903 (45.15%)	1104 (55.20%)	
Secondary or above	344 (17.20%)	793 (39.65%)	
Single, divorced, or widowed	931 (46.55%)	240 (12.00%)	<0.0001
Living alone	341 (17.05%)	92 (4.60%)	<0.0001
Housewife	206 (10.30%)	—	
Weight	54.52 (8.50)	62.44 (9.38)	<0.0001
Height	150.92 (5.32)	163.08 (5.72)	<0.0001
BMI			0.1081
Underweight (<18.5)	100 (5.00%)	115 (5.75%)	
Normal (18.5–<23)	711 (35.55%)	760 (38.00%)	
Overweight (≥23)	1189 (59.45%)	1125 (56.25%)	

* P value of t-test for continuous and χ^2 for categorical variables.

status, and BMI found that only educational level had a consistently positive association with adequate intake of most nutrients (Table 4). Single or divorced marital status is a risk factor in over-intake of saturated fatty acid of total energy in men. It is also a risk factor of under-intake in zinc and meat in women (Table 5). There is no association between BMI, age, living and socioeconomic status, and nutritional status. Therefore, body weight cannot reflect whether the subject is having the appropriate diet or not. The undernutrition was more serious when age advanced in both men and women (Tables 6 and 7).

4. Discussion

Our results showed that malnutrition exists amongst the elderly in Hong Kong Chinese elderly. They have a low intake of fibre, Calcium, and Vitamin D. On the other hand, they have an overconsumption of fat and cholesterol. Their diets are not appropriate for their needs, possibly contributing to the burden of chronic disease and/or poor control of existing illnesses such as osteoporosis, cardiovascular disease, and high fat diet-related cancer. This is reflected by the ongoing upward trend in age standardized cancer rate in breast cancer and male colorectal cancer which are most closely contributed by inappropriate dietary intake [15]. The International Osteoporosis Foundation also pointed out that the hip fracture rate in Hong Kong has increased by 300% from the 1960s to the 1990s and now costs more than 17 million USD a year in acute hospital care [16]. The coronary heart disease has also risen from 38.6% in 1972 to 59.6% in 1992 [17]. It is also now the second commonest cause of death in Hong Kong. Comparison with another local study done 20 years ago showed that the protein intake has greatly improved in both men and women reflecting the increasing affluence of our society [10].

Our study showed that people with lower education level, single/divorced/widowed, or male gender are at higher nutritional risk. These findings were compatible with another study of the Chinese population in Singapore [9]. However, there is no increased risk with advanced age and or with lower socioeconomic level which is at variance with other studies, possibly reflecting the greater socioeconomic homogeneity in Hong Kong. Another study that showed BMI has a positive association with the nutritional status. However, in our study, there is no association. This is perhaps because the energy from fat is quite high in our subjects and therefore the BMI cannot be used as a proxy measurement of overall nutrition.

Factors contributing to the nutritional imbalance are complex. A previous study has demonstrated that Chinese elderly have poor nutritional knowledge and they held strong traditional Chinese or food-texture-related dietary restriction attitudes [18]. This study also showed elderly of younger age and higher educational level had better nutrition knowledge. Therefore, health and nutrition liturgy is very important in strategies for promoting health in the elderly. We did not ask the source of food. However, in Chinese culture, elderly people usually cook and eat at home. Therefore, a health promotion programme targeted at healthy home or healthy recipe can help solving this problem in elderly.

Our study has its own limitations. The use of food frequency questionnaires has the merit of alleviating the memory burden amongst the elderly and can be used to assess long-term diet and is less influenced by daily variation. The tool has also been validated and used in nutrition studies in Chinese populations. However, it cannot cover all the

Table 2: Median (IQR) nutrient intake of the male participants.

Nutrient per day	Median (IQR)	Recommended intakes	Percentage meeting the recommendation	Tolerable upper intake levels	Percentage over the upper intake
Vitamin A (μg)	929.47 (649.92, 1,322.95)	900[a]	52.25%	3000[a]	3.30%
Vitamin B1 (mg)	0.87 (0.67, 1.17)	1.2[b]	22.77%		
Vitamin B2 (mg)	0.94 (0.70, 1.27)	1.3[b]	23.62%		
Vitamin B3/niacin (mg)	15.05 (11.18, 22.89)	16[b]	45.10%	35[b]	12.66%
Vitamin C (mg)	140.10 (98.73, 195.44)	90[c]	79.58%	2000[c]	0%
Vitamin D (μg)	0.19 (0.07, 0.41)	10[d]	0%	50[d]	0%
Calcium (mg)	575.80 (411.98, 779.35)	1200[d]	4.40%	2500[d]	0%
Phosphorous (mg)	1,058.23 (806.95, 1,424.99)	700[d]	84.38%	3000[d]	0.30%
Iron (mg)	14.56 (11.12, 19.19)	8[a]	92.94%	45[a]	0.35%
Zinc (mg)	9.62 (7.47, 11.96)	11[a]	33.73%	40[a]	0%
Iodine (μg)	0.29 (0.10, 1.06)	150[a]	0.10%	1100[a]	0%
Copper (μg)	0.12 (0.06, 0.23)	900[a]	0%	10000[a]	0%
Total energy (Kcal)	2,037.84 (1,675.09, 2,457.42)	2330/2100[e]	36.39%		
Protein (g)	80.97 (62.24, 106.03)	56[f]	82.48%		
Protein (g)/body weight (kg)	1.32 (1.00, 1.74)	0.8[f]	88.59%		
Protein % of total energy	16.14 (13.91, 18.74)			35[f]	0%
Carbohydrate (g)	274.43 (225.50, 342.72)	130[f]	98.55%		
Fruit (g)	231.62 (154.67, 344.45)	300[g]	34.08%		
Vegetable (g)	208.36 (143.70, 305.36)	240[g]	40.84%		
Meat (g)	145.97 (99.00, 215.27)	160[g]	49.85%		
Fibre (g)	8.61 (6.21, 12.00)	16[g]	9.91%		
Cholesterol (mg)	200.54 (135.01, 288.74)			300[h]	22.32%
Fat % of total energy	28.63 (24.62, 32.95)			30[h]	41.19%
Saturated fatty acid % of total energy	6.71 (5.51, 8.02)			10[h]	5.11%
Monounsaturated fatty acid % of total energy	10.56 (8.87, 12.47)			12[h]	29.78%
Polyunsaturated fatty acid % of total energy	6.78 (5.60, 8.38)			6[h]	66.07%

[a] Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc, Jan. 9, 2001.
[b] Dietary Reference Intakes for Thiamin, Riboflavin, Niacin, Vitamin B6, Folate, Vitamin B12, Pantothenic Acid, Biotin, and Choline, Jun. 12, 2000.
[c] Dietary Reference Intakes for Vitamin C, Vitamin E, Selenium, and Carotenoids, Aug. 3, 2000.
[d] Dietary Reference Intakes for Calcium, Phosphorus, Magnesium, Vitamin D, and Fluoride, Jan. 1, 1997.
[e] 2330 for age 65–74, 2100 for age over 74, dietary reference values for food, energy, and nutrients for united kingdom, 1991.
[f] Dietary reference intakes for energy, carbohydrate, fibre, fat, fatty acids, cholesterol, protein, and amino acids, sep. 5, 2002.
Note: The reports for references a–f may be accessed via http://www.nap.edu/. Copyright 2002 by the National Academies. All rights reserved.
[g] Eat Smart! Follow the Food Pyramid!, Central Health Education Unit of the Department of Health, Hong Kong, 2005.
[h] Fats and oils in human nutrition, Food and Agriculture Organization of the United Nations and the World Health Organization, Rome, 19–26 Oct. 1993.

Table 3: Median (IQR) nutrient intakes in female participants.

Nutrient per day	Median (IQR)	Recommended intakes	Percentage meeting the recommendation	Tolerable upper intake levels	Percentage over the upper intake
Vitamin A (μg)	923.56 (669.18, 1,266.28)	700[a]	71.66%	3000[a]	2.30%
Vitamin B1 (mg)	0.77 (0.58, 1.01)	1.1[b]	17.78%		
Vitamin B2 (mg)	0.82 (0.60, 1.11)	1.1[b]	26.14%		
Vitamin B3/niacin (mg)	10.48 (8.08, 14.73)	14[b]	27.74%	35[b]	6.01%
Vitamin C (mg)	140.84 (101.17, 187.45)	75[c]	88.03%	2000[c]	0%
Vitamin D (μg)	0.19 (0.08, 0.38)	10[d]	0%	50[d]	0%
Calcium (mg)	527.55 (376.39, 713.50)	1200[d]	2.70%	2500[d]	0%
Phosphorous (mg)	886.05 (683.21, 1,167.16)	700[d]	73.01%	3000[d]	0.10%
Iron (mg)	11.66 (9.19, 15.30)	8[a]	84.58%	45[a]	0.30%
Zinc (mg)	7.38 (5.91, 9.27)	8[a]	40.31%	40[a]	0%
Iodine (μg)	0.36 (0.10, 5.53)	150[a]	0%	1100[a]	0%
Copper (μg)	0.07 (0.04, 0.14)	900[a]	0%	10000[a]	0%
Total energy (Kcal)	1,504.03 (1,262.64, 1,843.71)	1900/1810[e]	23.08%		
Protein (g)	60.50 (46.44, 77.45)	46[f]	75.81%		
Protein (g)/ body weight (kg)	1.12 (0.85, 1.47)	0.8[f]	79.07%		
Protein % of total energy	15.97 (13.72, 18.41)			35[f]	0.15%
Carbohydrate (g)	216.63 (180.31, 261.49)	130[f]	95.29%		
Fruit (g)	212.89 (148.19, 315.74)	300[g]	28.14%		
Vegetable (g)	207.42 (147.10, 288.72)	240[g]	37.56%		
Meat (g)	104.36 (69.53, 152.35)	160[g]	27.69%		
Fibre (g)	8.01 (5.89, 10.58)	16[g]	6.11%		
Cholesterol (mg)	133.71 (89.15, 190.70)			300[h]	6.21%
Fat % of total energy	26.75 (23.50, 30.74)			30[h]	28.99%
Saturated fatty acid % of total energy	5.92 (4.96, 7.02)			10[h]	2.40%
Monounsaturated fatty acid % of total energy	9.92 (8.40, 11.89)			12[h]	23.69%
Polyunsaturated fatty acid % of total energy	6.96 (5.78, 8.52)			6[h]	70.11%

[a] Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc, Jan 9, 2001.
[b] Dietary Reference Intakes for Thiamin, Riboflavin, Niacin, Vitamin B6, Folate, Vitamin B12, Pantothenic Acid, Biotin, and Choline, Jun 12, 2000.
[c] Dietary Reference Intakes for Vitamin C, Vitamin E, Selenium, and Carotenoids, Aug 3, 2000.
[d] Dietary Reference Intakes for Calcium, Phosphorus, Magnesium, Vitamin D, and Fluoride, Jan 1, 1997.
[e] 1900 for age 65–74, 1810 for age over 74, Dietary Reference Values for Food, Energy and Nutrients for United Kingdom, 1991.
[f] Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids, Sep 5, 2002.
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[g] Eat Smart! Follow the Food Pyramid!, Central Health Education Unit of the Department of Health, Hong Kong, 2005.
[h] Fats and oils in human nutrition, Food and Agriculture Organization of the United Nations and the World Health Organization Rome, 19–26 October 1993.

Table 4: Crude odds ratio and adjusted odds ratio of educational level in meeting nutrient recommendation.

Educational level	Female		Male	
	Crude odds ratio (95% CI)	Adjusted by logistic regression (95% CI)	Crude odds ratio (95% CI)	Adjusted by logistic regression (95% CI)
Vitamin B1				
No education	1	1	1	1
Primary or below	1.23 (0.95, 1.61)	1.20 (0.89, 1.60)	1.80 (0.97, 3.35)	1.67 (0.90, 3.13)
Secondary or above	2.02 (1.47, 2.77)	1.93 (1.36, 2.75)	3.12 (1.68, 5.81)	2.84 (1.51, 5.32)
Vitamin B2				
No education	1	1	1	1
Primary or below	1.64 (1.29, 2.07)	1.51 (1.17, 1.95)	1.35 (0.78, 2.36)	1.24 (0.71, 2.18)
Secondary or above	2.91 (2.19, 3.87)	2.65 (1.94, 3.62)	2.31 (1.33, 4.02)	2.08 (1.18, 3.65)
Vitamin B3				
No education	1	1	1	1
Primary or below	1.31 (1.04, 1.64)	1.19 (0.93, 1.52)	1.15 (0.76, 1.75)	1.12 (0.73, 1.74)
Secondary or above	2.40 (1.82, 3.16)	2.13 (1.57, 2.89)	1.92 (1.26, 2.94)	1.74 (1.12, 2.71)
Calcium				
No education	1	1	1	1
Primary or below	2.08 (1.03, 4.23)	1.70 (0.82, 3.51)	1.85 (0.44, 7.77)	1.61 (0.38, 6.81)
Secondary or above	3.30 (1.52, 7.19)	2.87 (1.26, 6.50)	3.18 (0.76, 13.31)	2.93 (0.70, 12.36)
Zinc				
No education	1	1	1	1
Primary or below	1.41 (1.15, 1.72)	1.21 (0.97, 1.50)	1.14 (0.73, 1.78)	1.09 (0.69, 1.73)
Secondary or above	2.50 (1.92, 3.25)	1.98 (1.49, 2.64)	1.60 (1.02, 2.51)	1.45 (0.91, 2.32)
Fruit				
No education	1	1	1	1
Primary or below	1.17 (0.94, 1.46)	1.13 (0.89, 1.44)	1.81 (1.11, 2.94)	1.65 (1.00, 2.70)
Secondary or above	1.91 (1.45, 2.51)	1.84 (1.36, 2.49)	2.20 (1.34, 3.60)	1.97 (1.19, 3.26)
Vegetable				
No education	1	1	1	1
Primary or below	1.07 (0.87, 1.31)	0.96 (0.77, 1.19)	1.97 (1.24, 3.12)	1.79 (1.12, 2.87)
Secondary or above	1.28 (0.98, 1.66)	1.04 (0.78, 1.39)	2.35 (1.47, 3.74)	2.15 (1.33, 3.46)
Meat				
No education	1	1	1	1
Primary or below	1.16 (0.93, 1.45)	1.04 (0.82, 1.33)	1.11 (0.74, 1.66)	1.05 (0.69, 1.60)
Secondary or above	1.55 (1.17, 2.04)	1.26 (0.93, 1.72)	1.46 (0.97, 2.21)	1.31 (0.85, 2.02)
Fibre				
No education	1	1	1	1
Primary or below	1.72 (1.10, 2.69)	1.89 (1.14, 3.11)	1.14 (0.54, 2.43)	1.10 (0.52, 2.35)
Secondary or above	2.48 (1.48, 4.15)	2.46 (1.37, 4.42)	1.58 (0.74, 3.35)	1.46 (0.68, 3.13)

Table 5: Marital status as a risk factor in overintake of saturated and monounsaturated fatty acid of total energy and underintake of zinc and meat.

Variable	Female		Male	
	Crude odds ratio (95% CI)	Adjusted by logistic regression (95% CI)	Crude odds ratio (95% CI)	Adjusted by logistic regression (95% CI)
Meeting nutrient recommendation of Zinc				
Single/divorced/widowed	0.64 (0.53, 0.76)	0.72 (0.58, 0.88)	0.68 (0.51, 0.93)	0.73 (0.53, 1.00)
Meeting nutrient recommendation of meat				
Single/divorced/widowed	0.58 (0.48, 0.71)	0.57 (0.45, 0.72)	0.87 (0.66, 1.13)	0.94 (0.71, 1.25)
Over-intake of saturated fatty acid in total energy				
Single/divorced/widowed	0.89 (0.50, 1.58)	0.84 (0.43, 1.65)	1.86 (1.12, 3.09)	1.91 (1.11, 3.31)

Table 6: Median/frequency (%) among different age groups of the male participants.

	Median/frequency (%)			P value
	65–69	70–74	75 or above	
N	664	708	628	
Education level				<.0001
No education	27 (4.07%)	43 (6.07%)	33 (5.25%)	
Primary or below	316 (47.59%)	401 (56.64%)	387 (61.62%)	
Secondary or above	321 (48.34%)	264 (37.29%)	208 (33.12%)	
Single, divorced, or widowed	47 (7.08%)	68 (9.6%)	125 (19.9%)	<.0001
Living alone	21 (3.16%)	26 (3.67%)	45 (7.17%)	0.0009
Weight	63.80	62.80	61.00	<.0001
Height	163.95	162.95	162.30	<.0001
BMI	23.56	23.52	23.15	0.0009
Nutrient per day				
Vitamin A (μg)	954.72	929.71	912.03	0.4011
Vitamin B1 (mg)	0.88	0.89	0.86	0.1167
Vitamin B2 (mg)	0.96	0.93	0.91	0.1474
Vitamin B3/niacin (mg)	15.96	15.28	13.92	<.0001
Vitamin C (mg)	139.12	141.43	138.84	0.9536
Vitamin D (μg)	0.23	0.19	0.17	0.0455
Calcium (mg)	578.16	575.74	573.91	0.1867
Phosphorous (mg)	1,079.64	1,072.06	1,018.04	0.0032
Iron (mg)	15.04	14.58	14.00	0.0028
Zinc (mg)	9.86	9.63	9.28	0.0193
Iodine (μg)	0.34	0.30	0.25	0.0147
Copper (μg)	0.13	0.12	0.10	<.0001
Total energy (Kcal)	2,065.75	2,050.85	1,997.49	0.0021
Protein (g)	84.12	81.66	78.17	0.0024
Protein (g)/body weight (kg)	1.35	1.33	1.29	0.2816
Protein % of total energy	16.50	16.07	15.89	0.0423
Carbohydrate (g)	280.08	272.05	269.04	0.0534
Fruit (g)	231.27	230.60	234.04	0.831
Vegetable (g)	215.32	210.49	195.84	0.0741
Meat (g)	151.83	147.12	139.55	0.0142
Fibre (g)	8.68	8.72	8.27	0.3217
Cholesterol (mg)	207.60	202.11	195.64	0.02
Fat % of total energy	28.60	28.85	28.33	0.638
Saturated fatty acid % of total energy	6.69	6.82	6.62	0.3391
Monounsaturated fatty acid % of total energy	10.48	10.62	10.53	0.6339
Polyunsaturated fatty acid % of total energy	6.77	6.84	6.75	0.9904

Table 7: Median/frequency (%) among different age groups of the female participants.

	Median/frequency (%)			P value
	65–69	70–74	75 or above	
N	669	665	666	
Education level				<.0001
No education	189 (28.25%)	259 (38.95%)	305 (45.8%)	
Primary or below	334 (49.93%)	290 (43.61%)	279 (41.89%)	
Secondary or above	146 (21.82%)	116 (17.44%)	82 (12.31%)	
Single, divorced, or widowed	187 (27.95%)	273 (41.05%)	471 (70.72%)	<.0001
Living alone	66 (9.87%)	92 (13.83%)	183 (27.48%)	<.0001
Housewife	48 (7.17%)	60 (9.02%)	98 (14.71%)	<.0001
Weight	55.00	54.90	52.35	<.0001
Height	152.40	151.00	149.70	<.0001
BMI	23.61	24.15	23.34	<.0001
Nutrient per day				
Vitamin A (μg)	952.94	931.52	869.95	0.0049
Vitamin B1 (mg)	0.81	0.78	0.73	0.0898
Vitamin B2 (mg)	0.86	0.84	0.78	0.0013
Vitamin B3/niacin (mg)	11.26	10.48	10.05	<.0001
Vitamin C (mg)	143.18	140.12	139.28	0.5009
Vitamin D (μg)	0.16	0.18	0.24	0.0113
Calcium (mg)	545.03	543.82	495.06	0.0021
Phosphorous (mg)	937.45	900.81	842.84	0.0003
Iron (mg)	12.16	11.62	11.09	0.0001
Zinc (mg)	7.60	7.54	6.99	0.0003
Iodine (μg)	0.36	0.39	0.32	0.1767
Copper (μg)	0.09	0.07	0.06	<.0001
Total energy (Kcal)	1,550.90	1,497.26	1,463.53	0.0002
Protein (g)	63.30	60.91	56.74	<.0001
Protein (g)/body weight (kg)	1.15	1.13	1.08	0.1801
Protein % of total energy	16.18	16.01	15.64	0.0023
Carbohydrate (g)	221.86	217.75	213.27	0.0471
Fruit (g)	225.07	205.63	210.87	0.0897
Vegetable (g)	220.46	211.91	192.34	<.0001
Meat (g)	108.15	107.55	97.20	0.0004
Fibre (g)	8.32	8.02	7.56	0.0042
Cholesterol (mg)	137.10	136.95	128.93	0.0058
Fat % of total energy	27.09	27.16	26.10	0.1161
Saturated fatty acid % of total energy	5.91	6.04	5.82	0.3437
Monounsaturated fatty acid % of total energy	10.03	9.84	9.76	0.0499
Polyunsaturated fatty acid % of total energy	6.90	6.91	7.04	0.6163

individualized items of food and therefore does not capture some extreme diet range. Our study recruitment was not done by random sampling although we tried stratifying our subjects to cover a wider range of age and their BMIs are no different from the mean values of Hong Kong elderly. Our subjects are all ambulatory and therefore they cannot represent the elderly who live in institutions. Moreover, recruitment by self-referral usually will attract more health conscious and healthier subjects.

Our study has shown that there are nutritional dietary imbalances including under- and overconsumption of a wide range of nutrients in Hong Kong elderly. Diets have

become westernized and rates of noncommunicable diseases increased. Our study has identified the health need of malnutrition problem in the elderly, and it also revealed that this problem existed across different socioeconomic classes. Education has played much influence on this health problem and therefore health promotion strategy should be adjusted according to the different educational levels. Health services should be targeted at promoting better diets and tackling barriers to healthier diet decisions.

Conflict of Interests

The authors declare that they have no conflict of interests.

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