Original Article

Protein food avoidance behaviour among cancer patients – perspectives of nutrient intake and diet quality

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Background and Objectives: Previous study reported that high proportion of Chinese cancer patients practise food avoidance behaviour for fear of cancer recurrence. The present study aims at documenting the degree of food avoidance behaviours and its association with nutrient intake and diet quality among Chinese cancer patients. **Methods and Study Design:** Cross-sectional face-to-face interviews were conducted with 245 patients suffering from nasopharyngeal and colorectal cancer to investigate their food avoidance behaviour. Participant's nutrient intake was assessed by 3-day diet record. Diet quality was measured by Diet Quality Index – International (DQI-I). **Results:** As many as 86% cancer participants reported practicing food avoidance behaviours. The nutrients to which less than half of the participants met its daily requirement include vitamin D (0%), vitamin E (0.4%), calcium (7.8%), zinc (26.1%) and vitamin B1 (32.2%). Among all participants, only 47.8% met their daily energy requirement. Those reported having high degree of food avoidance behaviours are more likely to have low intake of protein, zinc and iron. However, there was no association between FAB and overall diet quality although the Variety subscale of DQI-I showed that food avoidance behaviours negatively link to participant's dietary sources of protein. **Conclusions:** Degree of practicing food avoidance behaviour is negatively associated with nutrients of animal origin, in particular protein. However, the overall diet quality was not affected by such. The study results provided important information to frontline clinical workers who are dealing with cancer patients practising non-mainstream diet.

Key Words: cancer patients, dietary intake, diet quality, food avoidance behaviour, malnutrition

INTRODUCTION

According to International Agency for Research on Cancer, there were approximately 19 million new cases of cancer in 2020 and nearly 10 million of deaths.[1] Yet, advances in cancer screening and treatment have led to a substantial decline in cancer mortality resulting in a dramatic increase in the number of cancer survivors. For instance, in the United States, the number of cancer survivors was 16.9 million in 2019 and is projected to reach 22.2 million in 2030.[2] Similarly, in China the amount of cancer survivors has been on the rise with no sign of levelling off.[3]

The improvement in survival does not necessarily lead to a healthy living among cancer patients. Malnutrition is common at different stages of their disease. For instance, previous study revealed that as many as 52% of gastrointestinal cancer patients suffer from malnutrition during their course of treatment and rehabilitation.[4] Malnourished cancer patients are more prone to develop complications, stay longer in hospital and have lower survival time.[5-7] Also, since cancer survivors are more likely to suffer from chronic diseases and experience cancer recurrence,[8-11] the need of a good nutrition is even more critical than in the general population.

Dietary intake and food choice among China are strongly influenced by traditional Chinese Medicine (TCM). In Hong Kong, for instance, 62% of the population consults traditional TCM doctors[12] who offer dietary advice in addition to herbal medicine treatment. According to TCM, some common food items are harmful to the body and can aggravate specific diseases.[13] Thus, in Chinese culture it is commonly believed by the lay population that many everyday food items will have deleterious health effects for various diseases. Certain food items are believed to cause allergic reactions such as tissue inflammation and therefore cancer patients are advised to avoid them.[14] Nevertheless, these patients may oversimplify TCM perspectives. Also, they frequently receive conflicting dietary information from various sources,[15] including folk beliefs that are not necessarily approved by TCM doctors.[16,17] As a result, many cancer patients frequently self-prescribe a diet that involves long-term food avoidance behaviour (FAB) of commonly consumed food items.

Yung et al previously noted that Chinese cancer patients practise different forms of food avoidance behave-

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iour.[18] Of which, a substantial proportion avoided the intake of certain protein-rich food items that are from animal sources that are perceived as "poisonous". Given that long term avoidance of certain food categories may lead to nutrient deficiency, and that malnutrition among cancer patients may result in serious disease complications, there is an urgent need to understand the nutrient intake among Chinese cancer patients. This paper aims to investigate the association between FAB and nutritional intake among Chinese cancer patients. There are two objectives. First, it is to correlate the Number of Avoided Protein-rich Food items (NAPF, to be described in Methods) with energy and nutrient intakes among cancer patients. Second, the association between NAPF and diet quality will also be investigated. As mentioned earlier, cancer patients have a higher risk of developing some chronic diseases and cancer recurrence compared to healthy people.[8,19,20] Since an individual's diet quality has been shown to have stronger association with chronic disease than single-index measures,[21] this may present a better indicator for having a poor nutritional status among cancer patients. We hypothesised that higher level of NAPF is associated with a lower intake of energy and protein, as well as a lower diet quality.

METHODS

Study subjects of the present study were cancer patients receiving medical consultations from two out-patient oncology clinics in Hong Kong (The Prince of Wales Hospital and The Pamela Youde Nethersole Eastern Hospital). Convenience sampling was adopted for this survey with the two sites recruited roughly equal number of subjects. Inclusion criteria of the subjects were: 1) age between 18 to 69 years, and 2) nasopharyngeal cancer (NPC) or colorectal cancer (CRC) patients. Exclusion criteria included 1) patients who had received treatment within the last three months, 2) those were undergoing cancer treatment or had planned treatment, and 3) patients who had distant metastasis or were at the end-stage of cancer. These criteria ensured the study subjects' dietary intake was not overly affected by cancer symptoms or treatment-related side effects.

Participants were interviewed separately and anonymously by a research assistant trained in nutritional science. In addition to a face-to-face questionnaire, the participant was requested to fill out a 3-day food record and return it to the research team by mail. They were given an incentive of supermarket coupon to compensate for their time. A total of 346 eligible patients were invited to join the study, of whom 273 (78.9%) completed the face-to-face interview and 245 (70.8%) returned their completed 3-day food record. Research ethics approval of this study was obtained from the Survey and Behavioural Research Ethics Committee of The Chinese University of Hong Kong.

Number of avoided protein-rich food items (NAPF) was used to represent a specific dietary taboo of protein foods. Participants were asked if they had avoided (either partially or completely) eating nine common protein-rich food groups/items: 1) fish (without scales e.g. eel), 2) poultry, 3) beef, 4) seafood (excluding fish), 5) milk and milk products, 6) fish (with scales), 7) eggs, 8) pork, 9) soy and soy products. The outcome variable NAPF is the sum of the above nine protein food items avoided by the participants.

Energy and nutrient intakes were analysed based on the 3-day food record. A food photo album was supplied to participants for estimation of serving and portion sizes. They were asked to record their detailed food and beverage intakes while maintaining their usual food habits over two weekdays and one weekend day, and to return the 3-day food record within 24 hours of completion. If needed, the participant was later contacted to clarify any questionable quantities of food items. The completed food record was analysed by Food Processor Nutrition Analysis V8.0 (ESHA Research, Salem, OR, USA). To accommodate local food variation, additional Chinese recipes were imported to the original database for analysis. Since World Cancer Research Fund and American Institute for Cancer Research recommend non-critical cancer patients eat according to the same dietary principles as healthy individuals,[22,23] the participant's daily energy requirement was calculated using the Harris-Benedict equation[24] based on the respondent's body weight, height and age. It was then multiplied by an assigned activity factor obtained by referring to participant's occupation and reported daily activity. Daily protein requirements were estimated at 0.8 g protein per 1 kg current body weight (US Recommended dietary allowance) (US RDA).[25]

This study adopted the summative Dietary Quality Index-International (DQI-I)[26] to assess the diet quality of the participants. It has been validated for assessing diet quality of Chinese diet. In doing so, the analysed nutrient and food portion of each participant were compared against the 17 items of DQI-I (see Table 1). A higher score of each item represents a better quality of diet. The composite score for the DQI-I score ranges from 0 (worst quality) to 100 (best quality). The items of DQI-I comprise four domains (subscales). Variety subscale (maximum 20 points) denotes the overall variety of food sources from five food groups (meat/poultry/fish/egg; dairy/beans; grains; fruits; vegetables), as well as the variety of source of protein included in the diet. Adequacy subscale (maximum 40 points) evaluates the intake of beneficial nutrients against deficiency disorders. They include vegetable, fruit, grain, fibre, protein, iron, calcium and vitamin C. Moderation subscale (maximum 30 points) examines the intake of harmful food (empty calorie food) and nutrients (total fat, saturated fats, cholesterol, sodium) that need restriction. Overall balance subscale (maximum 10 points) evaluates the proportion of energy source from macronutrients (carbohydrate, protein and fat) and fatty acid composition (polyunsaturated fat, monounsaturated fat, saturated fat). Detailed cut-off values and corresponding scores are shown in Table 1.

Background characteristics, which include age, educational attainment, occupation and type of cancer were collected. In addition, participants were being asked for: 1) type of therapy received, 2) appetite before and after cancer diagnosis, and 3) perceived own nutritional status before and after cancer diagnosis.

Non-parametric Spearman's ρ was used to assess the linear correlation between different levels of NAPF and the mean intake of each specific nutrient. To test the hypothesis that participants who had higher levels of NAPF

Table 1. Percentage distribution of participants in various items of Diet Quality Index-International (DQI-I) (n=245)

Items/Scoring and criteria	% of participants
Total score (0-100 scores)	
0-25 scores	0
26-50 scores	8.6
51-75 scores	65.7
76-100 scores	25.7
Variety subscale (0-20 scores)	
Overall food group variety (meat /poultry/ fish/ eggs; dairy/beans; grain; fruit; vegetable) (0-15 scores)	
≥1 serving from each food group = 15 scores	4.1
Any 1 food group missing = 12 scores	36.7
Any 2 food groups missing = 9 scores	44.9
Any 3 food groups missing = 6 scores	14.3
Any 4 food groups missing = 3 scores	0.0
None from any food groups = 0 score	0.0
Within-group variety for protein source (meat, poultry, fish, dairy, beans, eggs) (0-5 scores)	
≥3 different sources = 5 scores	60.4
2 different sources = 3 scores	32.2
1 source = 1 scores	6.5
None = 0 score	0.8
Adequacy subscale (0-40 scores)	
Vegetable group† (0-5 scores)	
≥3-5 servings = 5, 0 serving = 0; scoring based on pro rata basis	
5 scores	12.2
3-4 scores	35.5
≤2 scores	52.2
Fruit group† (0-5 scores)	
≥2-4 servings = 5, 0 serving = 0; scoring based on pro rata basis	
5 scores	15.9
3-4 scores	31.4
≤2 scores	52.7
Grain group† (0-5 scores)	
≥6-11 servings = 5, 0 serving = 0; scoring based on pro rata basis	
5 scores	80.4
3-4 scores	18.0
≤2 scores	1.6
Fibre† (0-5 scores)	
≥20-30 g = 5, 0 g = 0; scoring based on pro rata basis	
5 scores	23.0
3-4 scores	46.5
≤2 scores	30.5
Protein (0-5 scores)	
≥10% of energy = 5, 0% of energy = 0; scoring based on pro rata basis	
5 scores	99.2
3-4 scores	0.8
≤2 scores	0.0
Iron (0-5 scores)	
≥100% RDA = 5, 0% RDA = 0 score; scoring based on pro rata basis	
5 scores	74.3
3-4 scores	19.2
≤2 scores	6.5
Calcium (0-5 scores)	
≥100% RDA = 5, 0% RDA = 0 score; scoring based on pro rata basis	
5 scores	8.6
3-4 scores	43.7
≤2 scores	47.8
Vitamin C (0-5 scores)	
≥100% RDA = 5, 0% RDA = 0 score; scoring based on pro rata basis	
5 scores	62.9
3-4 scores	23.3
≤2 scores	13.9

Nutrient intakes are based on daily consumption.
RDA: Recommended Dietary Allowance; PUFA: polyunsaturated fatty acid; MUFA: monounsaturated fatty acid; SFA: saturated fatty acid.
†Based on 1700 kcal /2200 kcal/2700 kcal diet.

Table 1. Percentage distribution of participants in various items of Diet Quality Index-International (DQI-I) (n=245) (cont.)

Items/Scoring and criteria	% of participants
Moderation subscale (0-30 scores)	
Total fat (0-6 scores)	
≤20% of total energy = 6 scores	36.3
>20-30% of total energy = 3 scores	49.0
>30% of total energy = 0 score	14.7
Saturated fat (0-6 scores)	
≤7% of total energy = 6 scores	62.4
>7-10% of total energy = 3 scores	26.9
>10% of total energy = 0 score	10.6
Cholesterol (0-6 scores)	
≤300 mg = 6 scores	58.0
>300-400 mg = 3 scores	18.8
>400 mg = 0 score	23.3
Sodium (0-6 scores)	
≤2400 mg = 6 scores	73.5
>2400-3400 mg = 3 scores	18.0
>3400 mg = 0 score	8.6
Empty calorie foods (0-6 scores)	
≤3% of total energy = 6 scores	80.0
>3%-10% of total energy = 3 scores	10.6
>10% of total energy = 0 score	9.4
Overall balance subscale (0-10 scores)	
Macronutrient ratio (Carb:Protein:Fat) (0-6 scores)	
55~65:10~15:15~25 = 6 scores	1.6
52~68:9~16:13~27 = 4 scores	5.7
50~70:8~17:12~30 = 2 scores	9.8
Otherwise = 0 scores	82.9
Fatty acid ratio (PUFA:MUFA:SFA) (0-4 scores)	
P/S=1~1.5 and M/S=1~1.5 = 4 scores	6.5
Else if P/S=0.8~1.7 and M/S=0.8~1.7 = 2 scores	11.8
Otherwise = 0 score	81.6

Nutrient intakes are based on daily consumption.
RDA: Recommended Dietary Allowance; PUFA: polyunsaturated fatty acid; MUFA: monounsaturated fatty acid; SFA: saturated fatty acid.
†Based on 1700 kcal /2200 kcal/2700 kcal diet.

were less likely to meet the recommended daily intake of animal sourced nutrients, logistic regression analysis were conducted for each nutrient. Associations between NAPF and DQI-I was also assessed by Spearman's ρ. Statistical Package for the Social Sciences SPSS of Windows (Version 21) was used for the statistical analysis and a *p*-value of <0.05 was taken as statistically significance.

RESULTS

Of the 245 participants who completed all components of the study, 58% were male and 13.5% had a university education. About 29% of them were aged below 50. Respectively 48.6% and 22.9% of the participants were aged 50-59 and over 60. Less than half (44.1%) of the participants were nasopharyngeal cancer patients while the rest of them (55.9%) were colorectal cancer patients. The percentage of participants having received radiotherapy, chemotherapy and surgical removal were 62.4%, 74.3% and 44.9% respectively. About 63% of participants reported they had a "good" or "very good" appetite before their cancer diagnosis, as compared with 52.2% after their cancer diagnosis. About 60% of participants perceived themselves at a "good" or "very good" nutritional status before their cancer diagnosis. This figure reduced to 53.5% after the cancer diagnosis.

As for NAPF, among the nine protein-rich food items, commonly avoided items include poultry (66.9%), seafood (exclude fish) (64.4%), fish (without scales) (57.2%), beef (56.7%), eggs (30.2%) and milk and milk products (15.9%). Prevalence of avoiding the remaining three items pork (13.8%), fish (with scale) (7.4%) and soy and soy products (5.7%) were relatively low. As with the number of avoided protein-rich food (NAPF), there were 13.5% of participants did not avoid any of them (NAPF=0) i.e. 86.5% of participants practised avoiding protein food items. The percentages of participants avoiding different numbers of protein foods are as follow: avoid 1 item (13.1%); 2 items (11.0%); 3 items (11.4%); 4 items (23.7%); 5 items (13.1%); 6 items (11.4%); 7 items (2.4%); 8 items (0.4%). No participant avoided all 9 food items (NAPF=9).

The participants' intake of energy and nutrient that are relevant to animal foods are shown in Table 2. Figure 1 shows the percentage of participants met the recommended intake of these energy and nutrients (if applicable). There were about half (47.8%) of the participants met the recommended intake of energy. With regards to protein, it shows that 91.4% of the participants met the recommended intake. Among the rest of nutrients concerned, those with less than half of the participants met the recommendations included vitamin D (0%), vitamin E (0.4%), cal-

Table 2. Energy and nutrient intakes of participants (n=245)

Nutrients	Male Mean (SD)	Female Mean (SD)	All Mean (SD)	Recommended intake†
Energy (kcal)	1890 (527)	1670 (473)	1800 (517)	Personalised‡
Protein (g)	93.3 (34.3)	75.5 (23.0)	85.8 (31.3)	46-56
% total energy	19.7 (4.22)	18.5 (4.07)	19.2(4.19)	10-35
Total Fat (g)	49.3 (21.2)	41.2 (20.5)	45.9 (21.3)	Minimise
% total energy	23.2 (6.53)	22.2 (8.20)	22.8(7.28)	20-35
Cholesterol (mg)	341 (175)	250 (142)	303 (168)	Minimise
Vitamin B1(mg)	1.51 (0.70)	1.51 (0.70)	1.51 (0.70)	1.1-1.2
Vitamin B2 (mg)	1.42 (0.66)	1.33 (0.66)	1.38 (0.66)	1.1-1.3
Vitamin B12 (μg)	3.67 (2.58)	2.57 (1.61)	3.20 (2.29)	2.4
Vitamin D (μg)	1.38 (2.02)§	0.96 (1.15)§	1.21 (1.72)§	15
Vitamin E (mg)	3.55 (1.87)§	3.72 (2.35)§	3.62 (2.08)§	15
Calcium (mg)	626 (342)§	581 (274)§	607 (315)§	1000-1200
Zinc (mg)	9.21 (3.53)	7.20 (2.26)§	8.37 (3.21)	8-11
Iron (mg)	14.9 (9.23)	13.8 (9.47)	14.4 (9.33)	8-18
Magnesium (mg)	260 (104)§	235 (84.3)§	250 (97.3)§	310-420

†Based on Acceptable Macronutrient Distribution / Recommended Dietary Allowances / Adequate Intakes of the US's Dietary Reference Intakes.
‡Energy requirement was calculated by Harris-Benedict equation which depends on factors including gender, age, body weight and physical activity level.
§Denotes an intake lower than the recommended value.

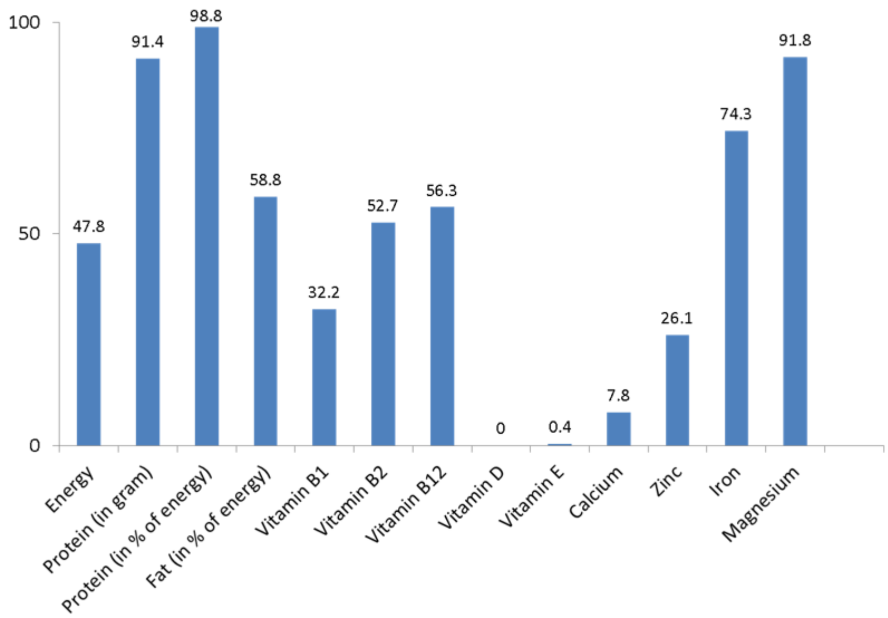

Figure 1. Percentage of participants meeting recommendation of energy and various nutrients (n=245).

cium (7.8%), zinc (26.1%) and vitamin B1 (32.2%). For the remaining nutrients (vitamin B2 (52.7%), vitamin B12 (56.3%), iron (74.3%) and magnesium (91.8%)), there were more than half of the participants who obtained the recommended intakes.

The association between NAPF and energy / nutrient intakes is summarised in Table 3. Those who avoided more protein-rich food items had significantly lower intake of protein in gram (Spearman's ρ=-0.19, p<0.01), protein as % of energy (Spearman's ρ=-0.15, p<0.05), total fat in gram (Spearman's ρ=-0.19, p<0.01), total fat in % of energy (Spearman's ρ=-0.20, p<0.01), cholesterol (Spearman's ρ=-0.19, p<0.01), zinc (Spearman's ρ=-0.18, p<0.01) and iron (Spearman's ρ=-0.13, p<0.05). No significant association was found between NAPF and the rest of the listed nutrients.

Further tests were done to investigate if participants with higher levels of NAPF were less likely to meet the recommended daily intake of energy and nutrients (see Table 4). It was found that a higher level of NAPF was associated with a lower likelihood of meeting the recommended intake of zinc (OR=0.88(95% CI=0.76-0.98)) and iron (OR=0.87(95% CI=0.78-0.95). NAPF was not associated with the meeting of recommended intake of other listed nutrients.

The percentage distribution of participants in various DQI-I component scores are shown in Table 1. In terms of total score, the mean (SD), lowest and highest scores were respectively 67.0 (10.7), 35.3 and 88.3. There were 0%, 8.6%, 65.7% and 25.7% of participants obtained 0-25, 26-50, 51-75 and 76-100 scores respectively. With regards to the variety subscale of DQI-I, majority of partic-

Table 3. Participants' energy and nutrient intakes according to quartiles of NAPF (n=245)

	NAPF (number of avoided protein food items)				
Nutrients, mean (SD)	Q1(0-1) (n=65)	Q2(2-3) (n=55)	Q3(4) (n=58)	Q4 (5-8) (n=67)	Spearman's $\rho^{\dagger}$
Energy (kcal)	1870 (560)	1800 (548)	1850 (500)	1690 (450)	-0.10
Protein (g)	90.9 (29.2)	91.5 (37.1)	86.2 (35.0)	79.0 (21.2)	-0.19**
% total energy	19.7 (3.7)	20.2 (4.8)	18.6 (4.2)	18.4 (3.9)	-0.15*
Total Fat (g)	51.0 (25.4)	50.5 (19.4)	45.7 (21.0)	37.5 (15.6)	-0.19**
% total energy	24.2 (8.0)	25.2 (6.5)	22.1 (7.5)	19.9 (6.0)	-0.20**
Cholesterol (mg)	314 (161)	347 (146)	308 (169)	251 (180)	-0.19**
Vitamin B1(mg)	1.5 (0.7)	1.5 (0.7)	1.6 (0.6)	1.6 (0.8)	0.08
Vitamin B2 (mg)	1.4 (0.7)	1.3 (0.5)	1.4 (0.6)	1.4 (0.8)	0.02
Vitamin B12 (μg)	3.4 (2.2)	3.5 (2.3)	3.1 (2.8)	2.9 (1.9)	-0.09
Vitamin D (μg)	1.1 (1.3)	1.0 (1.3)	1.5 (2.2)	1.2 (1.9)	-0.03
Vitamin E (mg)	4.0 (2.7)	3.7 (1.6)	3.6 (2.0)	3.3 (1.8)	-0.07
Calcium (mg)	594 (307)	562 (260)	673 (382)	600 (299)	0.03
Zinc (mg)	9.0 (3.3)	9.0 (3.9)	8.1 (2.9)	7.5 (2.5)	-0.18**
Iron (mg)	15.1 (12.7)	12.9 (5.7)	12.8 (7.9)	12.0 (9.0)	-0.13*
Magnesium (mg)	245 (88.9)	247 (83.6)	261 (130.0)	246 (80.7)	0.01

†Spearman's ρ between NAPF and each specific nutrient.
*p<0.05; ** p<0.01; ***p<0.001.

Table 4. Percentage of participants meeting dietary recommendation of energy and nutrients among different values of NAPF (n=245)

Nutrients	% of participants met recommendation					OR (95% CI)†
	NAPF (number of avoided protein food items)					
	≤1 (n=65)	2 (n=27)	3 (n=28)	4 (n=58)	≥5 (n=67)	
Energy (kcal)	49.2	55.6	46.4	48.3	43.3	0.96 (0.85-1.09)
Protein (g)	93.8	92.6	89.3	87.9	92.5	0.94 (0.75-1.18)
% total energy	100.0	100.0	96.4	98.3	98.5	0.75(0.40-1.41)
Total Fat (g)	-	--	--	--	--	--
% total energy	53.8	63.0	78.6	60.3	52.2	1.04(0.92-1.18)
Cholesterol (mg)	--	--	--	--	--	--
Vitamin B1(mg)	43.1	29.6	35.7	29.3	23.9	0.88 (0.77-1.00)
Vitamin B2 (mg)	53.8	48.1	46.4	60.3	49.3	0.99 (0.88-1.13)
Vitamin B12 (μg)	64.5	60.6	60.7	55.2	50.7	0.93 (0.82-1.06)
Vitamin D (μg)	0.0	0.0	0.0	0.0	0.0	NA
Vitamin E (mg)	1.5	0.0	0.0	0.0	0.0	NA
Calcium (mg)	6.2	7.4	7.1	10.3	7.5	1.04 (0.83-1.31)
Zinc (mg)	30.8	25.9	39.3	25.9	16.4	0.88 (0.76-0.98)
Iron (mg)	73.8	74.1	71.4	71.9	72.6	0.87 (0.78-0.95)
Magnesium (mg)	92.3	92.6	96.4	87.9	92.5	1.01 (0.80-1.27)

†Logistic regression analysis; dependent variable: (meeting recommendation of the specific nutrient (1) vs not meeting recommendation (0)); independent variable: NAPF (continuous). Adjusted for age, gender and activity level.

ipants obtained a passing score for "overall food group variety" (85.7%) and "within-group variety for protein sources" (92.6%), reflecting they could obtain a satisfactory variety of food sources (see Table 1). For the adequacy subscale, in general the participants obtained good scores for most beneficial nutrients and food groups except for the "fruit group" (47.3%), "vegetable group" (47.7%) and "calcium" (52.3%), in which only about half of the participants obtained a passing score. This implied about half of the participants did not have satisfactory intake of the above three food groups / nutrient. For the Moderation subscale, between 76.8% - 91.5% of the participants obtained a passing score for all the listed harmful nutrients and food groups. Lastly, for the overall balance subscale, 82.9% and 81.7% participants did not obtain any score for "macronutrient ratio" and "fatty acid ratio" respectively, meaning that their macronutrient ratio (carbohydrate : protein : fat) and fatty acid ratio (polyunsaturated : monounsaturated : saturated) were not in line with the ideal recommendation.

The participants' mean (SD) DQI-I total, subscale and item scores are shown in Table 5. It is found that NAPF was not associated with DQI-I total score. With regards to the four subscales of DQI-I, NAPF was negatively associated with Variety subscale (Spearman's ρ=-0.11, p<0.05) and its item of "Within group variety for protein source" (Spearman's ρ=-0.20, p<0.01), i.e. those participants with higher levels of NAPF had less dietary protein sources. Under the adequacy subscale, NAPF was positively associated with grain (Spearman's ρ=0.15, p<0.05) and fibre (Spearman's ρ=0.14, p<0.05) i.e. those participants who avoided more protein-rich food items had a higher consumption of grain and dietary fibre. However, no significant association was found between NAPF and the adequacy subscale score. For the moderation subscale, NAPF was positively associated with the items of "total fat"

Table 5. Participants' Diet Quality Index-International (DQI-I) score and the association with NAPF (n=245)

DQI-I Component	Mean (SD)†	Spearman's ρ‡
DQI-I Total score	67.02 (10.73)	0.12
Variety	13.97 (2.76)	-0.11*
Overall food group variety	9.92 (2.29)	-0.02
Within-group variety for protein source	4.05 (1.28)	-0.20**
Adequacy	29.72 (5.49)	0.03
Vegetable group	2.60 (1.38)	-0.07
Fruit group	2.39 (1.73)	0.08
Grain	4.78 (0.59)	0.15*
Fibre	3.29 (1.30)	0.14*
Protein	4.99 (0.15)	-0.08
Iron	4.61 (0.85)	0.03
Calcium	2.78 (1.16)	0.01
Vitamin C	4.28 (1.23)	-0.02
Moderation	22.31 (6.76)	0.16*
Total fat	3.65 (2.05)	0.14*
Saturated fat	4.56 (2.04)	0.16*
Cholesterol	4.04 (2.50)	0.14*
Sodium	4.95 (1.90)	0.02
Empty calorie foods	5.12 (1.89)	0.08
Overall balance	1.02 (1.73)	0.09
Macronutrient ratio	0.52 (1.28)	0.03
Fatty acid ratio	0.50 (1.13)	0.18**

NAPF: Number of avoided protein food item.
†A higher score reflects a better performance on that specific component.
‡Spearman's ρ between NAPF (independent variable) and each component score of DQI-I (dependent variable).

(Spearman's ρ=0.14, $p<0.05$), "saturated fat" (Spearman's ρ=0.16, $p<0.05$) and "cholesterol" (Spearman's ρ=0.14, $p<0.05$). It was also associated with the total score of this moderation subscale (Spearman's ρ=0.16, $p<0.05$) i.e. those participants who avoided more protein-rich foods had less dietary fat and cholesterol intake in general. For subscale of overall balance, NAPF was positively associated with the item of "fatty acid ratio" (Spearman's ρ=0.18, $p<0.01$) i.e. those participants who avoided more protein-rich foods were associated with a better profile of dietary fatty acid ratio.

DISCUSSION

Food avoidance behaviour among Chinese cancer patients is a new area of research. Despite its prevalence and history in the society, to our knowledge there is no previous study investigated the same realm of diet behaviour. Bell et al reported in their ethnographic study that Chinese cancer patients experienced contradictory cultural models of diet between Western medicine and TCM.[27] Specifically, there are some foods that are said to be "should avoid" in Chinese culture but no such idea according to Western medicine. Nevertheless, that study did not investigate how and to what extent Chinese cancer patients follow the dietary tradition. For the first time, the present study revealed that majority of Chinese cancer patients practise FAB in different extents. Given its potential leading to various nutrient deficiencies and serious health outcomes associated with this diseased population, there is an urgency to invest in this new research area and explore what might be the possible physiological outcomes of FAB.

Previous study by Yung et al[18] revealed that Chinese cancer patient population commonly practise three major forms of food avoidance behaviour that might co-exist in the same individual. There are significant proportion of patients who practise long term avoidance of food items that they perceive to be "nutritious". Meanwhile, a small proportion of them choose to avoid the attainment of a right amount of food intake. Both types of food avoidance behaviours are perceived to be beneficial in "suppress the growth of cancer cell" and "reduce the chance of cancer recurrence". Whilst these two forms of food avoidance possess a lower value of further investigation due to their unpredictability and non-uniformity, the current study focuses on the most prevalent form of food avoidance behaviour i.e. avoidance of specific protein-rich "poisonous" food items. Apparently, this self-reported dietary behaviour will lead to a reduction of dietary protein intake. Nonetheless, it is possible that the patients might replace their protein deficit by either taking other "less poisonous" protein foods or even supplement. Thus, it created a niche for investigating its association to nutrient intake as well as overall diet quality.

Our result proves that NAPF, which indicates the degree of practising "poisonous" food avoidance is negatively associated with protein intake in terms of both quantity and percent of energy intake. Simpsons et al previously illustrated the existence of poisonous-food-belief among the Chinese population.[15] This belief has been adopted by many cancer patients who chose to exercise it without consulting to their TCM doctor. Given most of the "poisonous" foods are animals origin, the adherence to the belief may reduce the intake of protein food items. There are two implications derived from the abovementioned association. First, it implies the subjects of current study did not have dietary compensation (of protein) when practising FAB, as manifested by a reduced intake of such nutrient. Second, because of the lack of intention compensating this nutrient, a minority of cancer patients belonging to the extreme end of NAPF are at risk of developing protein deficiency that in turn increases the risk of cancer recurrence and reduce survival.[8,11,28,29] Nevertheless, our result failed to show that NAPF correlates with a lower likelihood of meeting US RDA of protein. This is likely due to the fact that the general Hong Kong population has a high protein intake of 88g per day.[30] Thus, the majority of the study subjects, despite practising the dietary taboo still have their protein intake above US RDA.

The mean DQI-I overall score of the current participants was 67.0, which was higher than the study done by Kim et al who revealed the mean score of general Chinese population was 60.5.[26] It implied that diet quality of Chinese cancer patients of the present study was at least comparable to that of the general population. These findings indicate that dietary intake as a whole is not seriously compromised among cancer patients, which may be a result of reasonable access to a wholesome diet. Regarding the association between NAPF and diet quality, our hypothesis was merely partially supported i.e. NAPF was negatively associated with the variety subscale score but not the DQI-I overall score. A couple implications apply to this observation. First, in the preceding analysis we showed that NAPF was, as expected, negatively associated with protein intake quantitatively. The analysis on DQI-I variety subscale provided further information that NAPF did restrict cancer patients' sources of protein intake. Given that a good variety of protein sources ensures the adequate intake of all 20 amino acids, high level NAPF increases the risk of essential amino acid deficiency among cancer patients. Second, since NAPF was not associated with the DQI-I overall score, we could not conclude that practising such behaviour would lower the overall diet quality. In fact, NAPF was found positively associated with the moderation and overall balance subscale scores. This was mainly because of the lowered dietary fat intake as a result of the cutting down of animal foods. These positive associations likely cancelled out the negative association between NAPF and variety subscale, leading to the non-association between NAPF and DQI-I overall score.

Participant's intake of zinc and iron were negatively associated with NAPF. In Chinese diet, a significant proportion of zinc comes from animal foods,[31] with people living in urban setting have even higher reliance on such as compared with their rural counterparts.[32] That explains why participant's zinc intake decrease with number of avoided protein food items. Similarly, most rich sources of iron are of animal origin, particularly with red meat. Therefore, an increased value of NAPF likely reduces dietary iron. Furthermore, the plant source of zinc and iron usually has lower bioavailability due to the presence of inhibitor like phytate, as well as non-heme status of iron. Given both nutrients carry core functions in metabolism, immunity as well as circulation, their negative association with food avoidance behaviour should be highlighted to both cancer patient and their care-takers as a precaution measure.

Calcium intake of the current participants showed unsatisfactory level. There were only half of the participants obtained a passing score of in adequacy subscale for calcium. In fact, only 7.8% of them met the US RDA of calcium. Park et al revealed that from more than 5,000 Korean cancer patients in his study, only about 10.8% of them met the recommended intake of calcium averaging at 454mg/day.[33] The similar findings among the two studies may attribute to the lack of calcium food sources in traditional eastern Asian cuisine. Previous study showed that cancer survivors were more likely to develop osteoporosis.[34-36] Also, aged cancer survivors are more likely experience fall compared to their non-cancer counterparts.[37] Given the high mortality rate associated with elderly bone fracture, the need of promoting adequate calcium intake becomes an urgent topic to the cancer patient population especially those are of Asian origin.

There are a few limitations applied to this study. First, in measuring NAPF, we only asked about the kinds of protein-rich food items the participants avoided. The exact quantity of the protein-rich animal food items avoided was not captured. This limitation might affect the precision of the association between NAPF and a participants' protein intake. Second, we used 3-day diet record to capture the energy and nutrient intakes of the participants. Thus, common measuring errors associated with dietary reporting (e.g. under-reporting) also applied to our study. Third, there were also possible selection biases involved in this study. We sampled two types (nasopharyngeal and colorectal) of cancer patients for investigation from outpatient cancer clinics. Future research might extend the sampling to other groups of cancer patients to confirm the validity of the findings. Also, since our study excluded patients whose were on active treatment, applicability of the study result to those patients needs further investigation. Forth, since there are differences in meal composition among different Chinese localities (e.g. people in northern China generally consume high amount of animal foods), the generalisability of the present study's results is unknown. Further study is warranted to determine if our results could be used in setting outside Hong Kong.

In conclusion, the present study revealed that cancer patients practising higher degree of food avoidance behaviour had lower intakes of protein. Nevertheless, although NAPF was associated with less variety for protein source, our result did not support the hypothesis that high level of NAPF was associated with a lower overall diet quality. Thus, more evidence is needed to demonstrate the relationship between NAPF and risk of non-cancerous chronic diseases.

AUTHOR DISCLOSURES

The authors have no conflicts of interest to disclose.

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