Letter to the Editor

Current and Passive Smokers Have Poorer Quantity and Quality of Diet in Shanghai, China: A Cross-sectional Survey[*]

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Smoking is a major risk factor for chronic diseases, it has been estimated that 300 million adults currently smoke in China, and the smoking prevalence in males is as high as 52.9%, with 1 million smoking-related deaths yearly. Therefore, smoking is also a huge health burden in China[1]. Researchers have suggested an association between diet and smoking status with respect to both food and nutrient intakes. According to such studies, smokers tended to have a poor diet. Compared to non-smokers, smokers generally consumed more energy, total fat, saturated fat, and have lower intake of fruit, vegetables, fiber, vitamin C, and vitamin A[2,3]. Studies have also shown that smokers were less likely to meet the dietary reference intakes (DRIs) in some key nutrients[4].

However, few studies have paid attention to the overall dietary quality associated with different smoking status, and seldom take passive smokers into consideration. The relationship between smoking and diet has not been robustly studied in Shanghai or further afield in China. Therefore, our research employed nutrient intake evaluation and the Chinese Health Dietary Index (CHDI) to assess the quantity and quality of diet in adult residents with different smoking status in Shanghai, China.

Data was obtained from the 2010–2012 Chinese Nutrition and Health Surveillance[5] data for Shanghai. A multi-stage stratified random sampling and probability-proportional-to-size sampling method were chosen to select our study subjects. A total sample of 1,538 adults who completed the questionnaire for 24-h dietary recall and smoking status. The 72-h dietary recall method was used to assess all food and beverage consumption at home or outside, including dietary supplements. The family condiment weighing survey was used to acquire household condiment consumption. The two surveys were conducted simultaneously.

Nutrient intake was standardized according to a pre-validated standard coefficient. The standard was defined as a male adult (> 18 y) who experiences light physical labor with energy expenditure of 2,250 kcal/d. By dividing the nutrient intake by the standard coefficient, then we obtained standardized nutrient intake. Nutrient intake was compared with the Chinese Dietary Reference Intakes (DRIs) 2013, The Estimated Average Requirement (EAR) and The Recommended Nutrient Intake (RNI) were adopted.

The Chinese Health Dietary Index (CHDI)[6] was adopted in our study to evaluate the diet quality of participants, which contains 13 components. These included 9 food groups, food variety, calories from saturated fatty acid, empty calories, and sodium intake, with total points ranging from 0 to 100.

Smoking status was determined by smoking behaviors in the previous 30 days before investigation. They were categorized as 1) Current smokers: someone who smoked at least 1 cigarette every day on average in the past 30 days, 2) Current non-smokers: someone who never smoked or had not smoked in the past 30 days or smoked less than 1 cigarette each day on average, and 3) participants

who did not smoke but were exposed to passive smoking in the home or work place ≥ 15 min every day and ≥ 1 day every week were deemed to be passive smokers.

Smoking status was significantly associated with dietary intake in our study. Current smokers had significant changes in energy and main nutrient intake compared with current non-smokers. Current smokers and passive smokers had a lower CHDI, which translates to a poor quality diet. The CHDI scores were differed by regions and smoking status, with the score being better in the urban regions than suburban and rural regions. Current smokers had higher intake of fat than current non-smokers and passive smokers (P = 0.012), and lower carbohydrate intake than current non-smokers (P = 0.001) (Table 1). A German study demonstrated that smoking increased smell impairment and for heavy smokers (≥ 20 cigarettes/d), both smell and taste impairment[7]. The change in taste and smell may partly explain peculiar food choices amongst current and passive smokers. A higher intake of fat will contribute to unhealthy outcomes. One prospective cohort study followed 84,628 women (Nurses' Health Study, 1980 to 2010) and 42,908 men (Health Professionals Follow-up Study, 1986 to 2010), and indicated that substituting saturated fat for unsaturated fats (polyunsaturated fatty acids particularly) and/or high-quality carbohydrates can result in reduced CHD risk[8].

There were also significant differences in fiber, vitamin A, vitamin C (P < 0.05), with current non-smokers tending to consume more than current smokers and passive smokers for the aforementioned nutrients. Diets rich in vegetables and fruit can provide abundant dietary fiber but current and passive smokers had lower intake of these, which may contribute to low dietary fiber intake. Studies have suggested that intake of dietary fiber was inversely associated with colorectal cancer risk[9]. The dietary recommendation for fiber is 25–30 g/d, and the intake observed in our study was approximately one third of what it should be. Antioxidants such as vitamin A and vitamin C are substances that prevent the oxidation of other molecules and they can control free radicals in the body and prevent cell damage by neutralizing free radicals[10]. Smoking will generate large amounts of free radicals, and together with the lower intake of vitamin A and vitamin C and oxidative stress caused by smoking, this can increase the risk for chronic diseases in current and passive smokers.

The nutrient and energy intakes are shown compared with DRIs (Table 2). Nearly half of current smokers had protein intake meeting the RNI (49.1% of current non-smokers, 50.6% of current smokers, and 44.3% of passive smokers). There were no significant differences in calcium, iron, zinc, vitamin B1, and vitamin B2 (P > 0.05 for all) by smoking status, but a greater percentage of participants failed to meet the EAR for calcium, zinc, vitamin B1, and vitamin B2. Significant differences were found

Table 1. Nutrient intake from 72-h dietary recall data by smoking status [Median(P25, P75)]

Nutrient	Current non-smokers	Current smokers	Passive smokers	P
Energy (kcal)	1857.58 (1457.89, 2298.74)	1879.50 (1509.585, 2407.45)	1768.13 (1411.05, 2166.70)	0.012
Protein (g)	64.11 (50.24, 83.67)	65.45 (49.93, 83.30)	61.80 (48.68, 80.12)	0.201
Carbohydrate (g)	210.08 (164.21, 289.98)	198.89 (156.93, 272.34)	190.98 (155.01, 258.75)	0.001
Fat (g)	73.70 (55.79, 97.87)	81.72 (58.32, 112.21)	75.00 (55.96, 99.99)	0.012
Fiber (g)	9.57 (6.64, 14.10)	8.51 (5.77, 12.14)	8.42 (6.42, 12.15)	0.001
Vitamin A (μg RAE)	491.35 (310.06, 772.83)	436.47 (262.96, 650.45)	442.72 (285.14, 696.42)	0.002
Vitamin B1 (mg)	0.73 (0.56, 0.97)	0.77 (0.60, 1.02)	0.69 (0.55, 0.90)	0.002
Vitamin B2 (mg)	0.87 (0.62, 1.13)	0.85 (0.62, 1.11)	0.84 (0.60, 1.12)	0.549
Vitamin C (mg)	73.07 (46.89, 111.19)	66.63 (39.97, 99.77)	71.57 (47.76, 101.45)	0.014
α-Vitamin E (mg)	8.45 (5.28, 13.01)	8.64 (4.74, 13.19)	8.54 (5.25, 13.64)	0.817
Calcium (mg)	469.93 (326.84, 674.15)	432.04 (304.24, 617.34)	454.91 (320.88, 641.47)	0.023
Iron (mg)	19.52 (15.06, 25.35)	19.92 (15.65, 25.23)	18.96 (14.88, 24.63)	0.374
Zinc (mg)	10.08 (7.90, 12.60)	10.38 (8.36, 13.49)	9.80 (7.90, 12.35)	0.050
Sodium (g)	4189.49 (2965.03, 5652.89)	4509.05 (3014.22, 6092.29)	4260.76 (3153.25, 5762.76)	0.370

for intake of vitamin A (*P* = 0.044) and vitamin C (*P* = 0.011), the intake was unsatisfactory, although current non-smokers may experience some benefit. According to this comparison, we can better understand the differences with recommended intakes to give advices for current smokers and passive smokers. So, nutritionists should also pay attention to nutrient intake adequacy not only the differences between smoking status.

The CHDI point score of food variety, refined grains, whole grains, dry bean and tuber, total vegetables, dark green and orange vegetables, fruit, dairy, soybean, meat and egg, fish, shellfish and mollusc, calories from saturated fatty acid, empty calories, and sodium intake was 10.0, 5.0, 0.0, 5.0, 5.0, 4.0, 4.0, 3.6, 5.0, 5.0, 4.3, 10.0, and 0.0, respectively, with a median points total of 51.4 (Table 3). Significant differences were found in refined grains, fruit, dairy, meat and egg, sodium, calories from SoFAAS, empty calories, and total points (*P* < 0.05) by smoking status. Furthermore, a difference was also observed in total CHDI points

Table 2. Percentage of subjects meeting recommendations for selected nutrients by smoking status [*N* (%)]

Items		Current non-smokers	Current smokers	Passive smokers	*P*
Energy (kcal)	< 60%	123 (16.6)	55 (15.2)	92 (21.2)	0.098
	60%-80%	230 (31.0)	101 (27.9)	136 (31.4)	
	80%-100%	191 (25.7)	96 (26.5)	107 (24.7)	
	≥ 100%	199 (26.8)	110 (30.4)	98 (22.6)	
Protein (g)	< 60%	68 (9.2)	27 (7.5)	41 (9.5)	0.519
	60%-80%	148 (19.9)	73 (20.2)	88 (20.3)	
	80%-100%	162 (21.8)	79 (21.8)	112 (25.9)	
	≥ 100%	365 (49.1)	183 (50.6)	192 (44.3)	
Calcium (mg)	< EAR	541 (72.8)	283 (78.2)	332 (76.7)	0.091
	EAR-RNI	83 (11.2)	36 (9.9)	53 (12.2)	
	≥ RNI	119 (16.0)	43 (11.9)	48 (11.1)	
Iron (mg)	< EAR	14 (1.9)	7 (1.9)	4 (0.9)	0.301
	EAR-RNI	66 (8.9)	24 (6.6)	44 (10.2)	
	≥ RNI	663 (89.2)	331 (91.4)	385 (88.9)	
Zinc (mg)	< EAR	399 (53.7)	183 (50.6)	253 (58.4)	0.220
	EAR-RNI	152 (20.5)	73 (20.2)	78 (18.0)	
	≥ RNI	192 (25.8)	106 (29.3)	102 (23.6)	
Vitamin A (μgRAE)	< EAR	426 (57.3)	236 (65.2)	278 (64.2)	0.044
	EAR-RNI	141 (19.0)	63 (17.4)	70 (16.2)	
	≥ RNI	176 (23.7)	63 (17.4)	85 (19.2)	
Vitamin B1 (mg)	< EAR	657 (88.5)	304 (84.2)	387 (89.4)	0.221
	EAR-RNI	42 (5.7)	28 (7.8)	23 (5.3)	
	≥ RNI	43 (5.8)	29 (8.0)	23 (5.3)	
Vitamin B2 (mg)	< EAR	586 (79.1)	296 (81.8)	351 (81.1)	0.259
	EAR-RNI	61 (8.2)	34 (9.4)	41 (9.5)	
	≥ RNI	94 (12.7)	32 (8.8)	41 (9.5)	
Vitamin C (mg)	< EAR	444 (59.8)	247 (68.2)	266 (61.4)	0.011
	EAR-RNI	73 (9.8)	25 (6.9)	55 (12.7)	
	≥ RNI	226 (30.4)	90 (24.9)	112 (25.9)	

Note. EAR, estimated average requirement. RNI, recommended nutrient intake.

Table 3. CHDI score by smoking status and region [Median (P25, P75)]

Components	Current non-smokers				Current smokers				Passive smokers				Total	Maximum points
	Urban	Suburban	Rural	Total	Urban	Suburban	Rural	Total	Urban	Suburban	Rural	Total		
Food variety	10.0 (10.0, 10.0)	10.0 (10.0, 10.0)	10.0 (10.0, 10.0)	10.0 (10.0, 10.0)	10.0 (10.0, 10.0)	10.0 (10.0, 10.0)	10.0 (10.0, 10.0)	10.0 (10.0, 10.0)	10.0 (10.0, 10.0)	10.0 (10.0, 10.0)	10.0 (10.0, 10.0)	10.0 (10.0, 10.0)	10.0 (10.0, 10.0)	10
Refined grains	5.0 (5.0, 5.0)	5.0 (5.0, 5.0)	5.0 (5.0, 5.0)[a]	5.0 (5.0, 5.0)[b]	5.0 (5.0, 5.0)	5.0 (5.0, 5.0)	5.0 (5.0, 5.0)	5.0 (5.0, 5.0)[b]	5.0 (5.0, 5.0)	5.0 (5.0, 5.0)	5.0 (5.0, 5.0)[b]	5.0 (5.0, 5.0)	5.0 (5.0, 5.0)	5.0
Whole grain, dry bean and tuber	1.0 (0.0, 5.0)	0.0 (0.0, 3.6)	0.0 (0.0, 1.7)[a]	0.0 (0.0, 5.0)	0.0 (0.0, 5.0)	0.0 (0.0, 2.8)	0.0 (0.0, 3.2)[a]	0.0 (0.0, 5.0)	0.0 (0.0, 5.0)	0.0 (0.0, 3.3)	0.0 (0.0, 2.2)[a]	0.0 (0.0, 4.7)	0.0 (0.0, 0.0)	5.0
Total vegetables	5.0 (5.0, 5.0)	5.0 (5.0, 5.0)	5.0 (5.0, 5.0)	5.0 (5.0, 5.0)	5.0 (5.0, 5.0)	5.0 (5.0, 5.0)	5.0 (5.0, 5.0)	5.0 (5.0, 5.0)	5.0 (5.0, 5.0)	5.0 (5.0, 5.0)	5.0 (5.0, 5.0)	5.0 (5.0, 5.0)	5.0 (5.0, 5.0)	5.0
Dark and orange vegetables	5.0 (4.4, 5.0)	5.0 (4.9, 5.0)	5.0 (3.0, 5.0)[a]	5.0 (4.3, 5.0)	5.0 (4.9, 5.0)	5.0 (4.6, 5.0)	5.0 (3.9, 5.0)	5.0 (4.5, 5.0)	5.0 (3.5, 5.0)	5.0 (4.7, 5.0)	5.0 (2.7, 5.0)[a]	5.0 (3.7, 5.0)	5.0 (4.1, 5.0)	5.0
Fruit	9.9 (0.0, 10.0)	2.7 (0.0, 10.0)	0.0 (0.0, 5.5)[a]	5.4 (0.0, 10.0)[b]	1.2 (0.0, 10.0)	0.0 (0.0, 6.4)	0.0 (0.0, 7.8)[a]	0.0 (0.0, 10.0)[b]	7.5 (0.0, 10.0)	3.7 (0.0, 10.0)	0.0 (0.0, 8.8)[a]	4.6 (0.0, 10.0)[b]	4.0 (0.0, 10.0)	10.0
Dairy	10.0 (0.0, 10.0)	0.0 (0.0, 10.0)	0.0 (0.0, 0.0)[a]	0.0 (0.0, 10.0)[b]	0.0 (0.0, 10.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)[a]	0.0 (0.0, 10.0)[b]	10.0 (0.0, 10.0)	0.0 (0.0, 10.0)	0.0 (0.0, 0.0)[a]	0.0 (0.0, 10.0)[b]	4.0 (0.0, 10.0)	10.0
SoyBean	3.1 (0.0, 8.4)	2.4 (0.0, 9.5)	10.0 (1.4, 10.0)[a]	3.7 (0.0, 10.0)	3.5 (0.3, 9.0)	3.4 (0.0, 10.0)	10.0 (0.0, 10.0)[a]	3.9 (0.0, 10.0)	2.5 (0.3, 7.7)	2.1 (0.0, 9.8)	6.5 (0.0, 10.0)[a]	2.9 (0.0, 10.0)	3.6 (0.0, 10.0)	10.0
Meat and egg	5.0 (5.0, 5.0)	5.0 (5.0, 5.0)	5.0 (5.0, 5.0)[a]	5.0 (5.0, 5.0)[b]	5.0 (5.0, 5.0)	5.0 (5.0, 5.0)	5.0 (5.0, 5.0)[a]	5.0 (5.0, 5.0)[b]	5.0 (5.0, 5.0)	5.0 (5.0, 5.0)	5.0 (5.0, 5.0)[a]	5.0 (5.0, 5.0)[b]	5.0 (5.0, 5.0)	5.0
Fish, shellfish and mollusc	5.0 (3.9, 5.0)	5.0 (0.2, 5.0)	5.0 (1.4, 5.0)[a]	5.0 (2.7, 5.0)	5.0 (4.3, 5.0)	5.0 (2.6, 5.0)	5.0 (2.4, 5.0)	5.0 (3.6, 5.0)	5.0 (4.9, 5.0)	5.0 (1.2, 5.0)	5.0 (2.6, 5.0)[a]	5.0 (3.2, 5.0)	5.0 (3.1, 5.0)	5.0
Sodium	0.0 (0.0, 0.7)	0.0 (0.0, 1.2)	0.0 (0.0, 0.0)	0.0 (0.0, 0.7)[b]	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)	0.0 (0.0, 0.0)[b]	0.0 (0.0, 1.0)	0.0 (0.0, 1.9)	0.0 (0.0, 1.0)	0.0 (0.0, 1.1)[b]	0.0 (0.0, 0.3)	10.0
Calories from SoFAAS	4.6 (0.6, 9.0)	1.7 (0.0, 6.6)	9.9 (4.4, 10.0)[a]	4.8 (0.0, 10.0)[b]	2.9 (0.0, 6.9)	1.4 (0.0, 6.1)	8.3 (3.9, 10.0)[a]	3.5 (0.0, 7.9)[b]	3.1 (0.0, 7.1)	1.8 (0.0, 5.7)	8.8 (4.3, 10.0)[a]	3.7 (0.0, 8.3)[b]	4.3 (0.0, 9.2)	10.0
Empty calories	10.0 (8.9, 10.0)	9.1 (3.4, 10.0)	10.0 (8.4, 10.0)[a]	10.0 (7.6, 10.0)[b]	10.0 (6.7, 10.0)	8.3 (4.1, 10.0)	10.0 (7.6, 10.0)[a]	10.0 (6.0, 10.0)[b]	10.0 (6.4, 10.0)	8.3 (3.8, 10.0)	10.0 (8.2, 10.0)[a]	10.0 (5.9, 10.0)[b]	10.0 (6.6, 10.0)	10.0
Total point	58.4 (47.5, 65.6)	47.5 (37.5, 54.8)	50.0 (42.6, 59.6)[b]	53.1 (44.0, 62.8)[b]	50.9 (43.3, 60.3)	43.4 (35.9, 51.7)	50.0 (43.2, 54.9)[a]	49.2 (41.0, 56.2)[b]	53.9 (46.8, 62.6)	47.9 (37.5, 54.5)	50.3 (41.5, 55.0)[a]	51.4 (43.3, 58.6)[b]	51.4 (42.8, 60.2)	100.0

Note. [a]Comparison of CHDI between different regions in respective smoking status group, $P < 0.05$. [b]Comparison of CHDI by smoking status, $P < 0.05$.

(P < 0.05), and current non-smokers (53.1) had higher scores than passive smokers (50.9) and current smokers (49.2). Current smokers had lower CHDI points concerning fruit (5.4 of current non-smokers, 0.0 of current smokers, and 4.6 of passive smokers), while calories from saturated fatty acid also differed (4.8 of current non-smokers, 3.5 of current smokers, and 3.7 of passive smokers). The CHDI is density-based (e.g., amounts/1,000 kcal) rather than absolute amounts, and also is used to evaluate diet quality and health outcomes. Our results suggested that current and passive smokers had lower CHDI compared to current non-smokers. Based on data from the Chinese Nutrition and Health Surveillance (2010–2012) shown, adult (> 18 y of age) participants had a mean CHDI of 49.18 ± 11.89; our results suggested that both current and passive smokers had poor diet quality (< 60) according to the CHDI score[6]. Differences were also observed in regions by smoking status, where urban areas had a high score compared with suburban and rural areas. Therefore, more attention should also be paid to adjust the diet pattern accordingly for current and passive smokers, especially people of them in suburban and rural areas.

However, our study also had some limitations. Though the 3 days 24-h dietary recall survey is widely used in large epidemiological studies to estimate dietary intake and relationship between diet and disease, recall bias is inevitable. Because of small sample size (5.9%) of former smokers who smoked previously but had not smoked in the previous 30 days, our study did not divide into a separate group, and this may contribute to bias too. In addition, the cross-sectional study itself cannot determine the association of cause-effect between smoking status and dietary condition, and thus errors may occur.

In conclusion, current and passive smokers have a poorer dietary intake of some key nutrients and quality of diet compared with current non-smoking adult residents in Shanghai, indicating that these people are at increased health risk. Considering the unhealthy dietary patterns caused by smoking, public health policy and health education should focus on strengthening smoking cessation and to change the dietary habits of current and passive smokers.

The survey protocols, instruments, and the process for obtaining the informed consent for participants were approved by the ethics committee of Shanghai Center for Disease Control and Prevention. All participants and guardians provided written informed consent, together with a verbal explanation before the surveys.

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