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Characteristics of spicy food consumption and its relation to lifestyle behaviours: results from 0.5 million adults

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ABSTRACT

This study aimed to describe the characteristics and lifestyle differences of spicy food consumption in 0.5 million adults. Participants were recruited from 2004 to 2008 in the baseline research of the CKB study. Higher frequency and stronger pungency degree in spicy food positively correlated with preference for salty taste, eating snacks/deep-fried foods, tea/alcohol drinking and tobacco smoking. Among weekly tea/alcohol drinkers and current regular smokers, participants with a higher frequency of spicy food consumption or preference for stronger pungency degree were more likely to prefer strong tea, drink alcohol exceed the healthy amount, drink alcohol in the morning every day, smoke $\geq$ 40 cigarettes per day, consume a larger amount of tea leaves, alcohol and cigarettes each day, and start habitual tea/alcohol drinking or smoking at an earlier age. Differences existed in lifestyle factors related to major chronic diseases according to spicy food consumption frequency and pungency degree among the Chinese population.

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Introduction

Spices have been extensively used in cooking worldwide. Spicy food consumption and its nutrient substances, such as capsaicin and vitamins contained in chilli pepper, have been attracting increasing attention in recent years (Patowary et al. 2017; Bonaccio et al. 2019). Prospective studies have found that cumulative average chilli intake was inversely associated with overweight/obesity, diabetes, hypertension and mortality in the Chinese population (Lv et al. 2015; Shi et al. 2017; Shi et al. 2018). Moreover, capsaicin has shown its potential to treat rhinitis, diabetes, neurogenic bladder, various cancers, cardiovascular, gastrointestinal, and dermatologic diseases (Sharma et al. 2013; Fokkens et al. 2016; Sun et al. 2016; Zsiboras et al. 2018).

However, few studies have described the characteristics of spicy food consumption in a large population (Wang et al. 2019). More importantly, lack of comprehensive research on the relationship of spicy food consumption with health-related lifestyle behaviours, such as cigarette smoking, alcohol drinking, physical activity, dietary habits, etc., impeded us to fully understand its contribution to major chronic diseases and their interactions with those lifestyle behaviours. Therefore, we described the population distribution and behavioural characteristics of spicy food consumption among half a million participants in the China Kadoorie Biobank (CKB) study.

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Subjects and methods

Study population

The CKB study is a population-based prospective cohort study. Participants were recruited in 2004–2008, including 512,715 men and women aged 30–79 years from 10 areas (Qingdao, Harbin, Haikou, Suzhou, Liuzhou, Sichuan, Gansu, Henan, Zhejiang, Hunan) across China. About 5% of the participants were randomly invited to the resurvey during 2013–2014, involving 25,069 participants. Detailed descriptions of the CKB study have been published before (Chen et al. 2005; Chen et al. 2011).

In the baseline, we excluded individuals with self-reporting medical histories of diabetes ($n = 16{,}162$), cancer ($n = 2{,}578$), heart disease ($n = 15{,}472$) or stroke ($n = 8{,}884$). We also excluded two individuals with missing values on body mass index (BMI). The same excluding criteria applied to the second resurvey, 4,132 participants reported diseases mentioned above were excluded. Therefore, 474,015 participants in the baseline and 21,107 participants in the resurvey were eligible for the final analyses.

Assessment of covariates

In the baseline survey, we used a laptop-based questionnaire to face-to-face interview participants about their sociodemographic characteristics and lifestyle behaviours.

Sociodemographic characteristics included age, sex, marital status (married, widowed, separated or divorced, never married), education (no formal school, primary school, middle school, high school, technical school or college, university), household income (<2500, 2500–4999, 5000–9999, 10000–19999, 20000–34999, ≥35000 yuan per year) and occupation (manual worker, non-manual worker, not working).

Lifestyle behaviours included tea/alcohol drinking [never drinker, occasionally drinker, 1–5 days per week (d/w) and 6–7d/w], tobacco smoking (never/occasionally smoker, ex-regular smoker and current regular smoker) and physical activity. Details of drinking and smoking behaviours were further assessed among weekly tea/alcohol drinkers and current regular smokers: temperature of tea (warm, hot, burning hot), strength of tea (weak, moderate, strong), frequency of changing tea leaves per day and amount of tea leaves added each time, grams of alcohol consumption on a typical day, frequency of drinking alcohol in the morning, number of cigarettes smoked per day, and age of starting drinking tea/alcohol weekly or smoking regularly. Female who consumed alcohol >15 grams per day (g/d) or male who consumed >30 g/d were defined as an unhealthy drinker. Those smoking ≥40 cigarettes were defined as a heavy smoker. Total daily physical activity level was calculated by multiplying the metabolic equivalent tasks value for a particular type of physical activity by hours spent on that activity per day and summing the metabolic equivalent hours per day (MET-h/d) for all activities (Du et al. 2013). The physical activity was divided into three groups according to sex-specific tertiles of exercises (13.68 and 28.73 MET-h/d in male, 12.81 and 24.60 MET-h/d in female).

Assessment of dietary habits and spicy food consumption

In the second resurvey of CKB study, we used a semi-quantitative food frequency questionnaires (FFQ, Supplementary Material 2) to collect the information on the frequency (daily, 4–6 d/w, 1–3 d/w, monthly, never/rarely) and amount (grams unless specified) about major food groups, including rice, wheat, grains, meat, fish, poultry, fresh vegetables, preserved vegetables, fresh fruits, soya products, yoghurt, other dairy foods, soymilk (mL), milk (mL), other drinks (mL). Besides, participants reported their saltiness preference (very light, about average, very salty), daily condiments usage (e.g. salt, soy sauce, cooking oil) and the frequency of eating habits (e.g. snacking, skipping breakfast, eating deep-fried foods, eating western-type fast foods). Dietary intakes were calculated by multiplying the days of consuming specific food each week and the amount they ate each time. Daily energy intake was calculated by taking into account the 11 groups of foods (rice, wheat and grains, meat, fish, poultry, fresh vegetables, preserved vegetables, fresh fruits, soya products, yoghurt). Unhealthy eating habits were defined as having the following behaviours ≥1 d/w (snacking, skipping breakfast, eating deep-fried foods, eating western-type fast foods).

On top of the FFQ, a series of questions were asked to collect detailed information on spicy food consumption, such as the frequency, pungency degree (the strength of spiciness by subjective feeling), age of starting the habit, and the types of source of spicy food consumption (Supplementary Material 3). We asked participants about the frequency of their spicy food consumption during the past month, and possible answers were never or almost never, only occasionally, 1–2 d/w, 3–5 d/w, daily or almost every day. Weekly spicy food consumers were further asked about the age they started to eat spicy food weekly, the pungency degree of spicy food they usually preferred to eat (single choice allowed weak, moderate, and strong), and the main source of spice usually used (multiple choices allowed chilli sauce, chilli oil, dried chilli pepper, fresh chilli pepper, and others or did not know). The reproducibility of spicy food assessment was tested, and the Spearman's coefficient for the correlation between baseline and resurvey questionnaires was 0.71 (Lv et al. 2015).

Statistical considerations

The percentages and means of sociodemographic characteristics, dietary habits and lifestyle behaviours were described according to spicy food consumption frequency and pungency degree, using logistic regression and ANOVA (analysis of variance) model respectively, adjusting for age, sex, region, household income, education, occupation and marriage status unless specified. Linear trend was tested for age of starting habitual spicy food intake, pungency degree and sources of spicy food across frequency of spicy food consumption, dietary habits and all details of lifestyle behaviours across spicy food consumption frequency as well as pungency degree of spicy food, adjusting for age, sex, region, household income, education, occupation and marriage status, by assigning the midpoint values of each frequency category and treating the variable as continuous in a separate regression model.

The statistical analyses were performed with Stata (version 15.0). All P values were two-sided, and we defined statistical significance as $P < 0.05$.

Ethical statement

The Ethical Review Committee of the Chinese Centre for Disease Control and Prevention (Beijing, China) and the Oxford Tropical Research Ethics Committee at the University of Oxford (Oxford, UK), approved the study. Written informed consent was obtained from all participants.

Results

Among 474,051 participants with a mean age of (51.3 ± 10.5) years, 41% were male, and 30.8% were daily spicy food consumers. Daily consumers were more likely to be young non-manual workers. Among the regular consumers who reported ≥1 d/w in spicy food intake, 74,037 (36.2%) preferred strong pungency. The stronger pungency degree they preferred, the more they were likely to be young married, but the less likely to be highly educated and non-manual workers (Table 1).

Among the regular spicy food consumers, the higher frequency they reported, the stronger pungency they preferred (14.5% participants who consume spicy food 1–2 d/w preferred strong pungency, while the corresponding percentage was 42.1% of daily consumes), and the earlier age of starting the habit they reported (17.9 years old in 1–2 d/w consumers vs. 14.5 years old in daily consumers, P for trend < 0.001,

Table 1. Baseline characteristics according to spicy food consumption.

	Frequency (%, SE)				Pungency degree (%, SE)[a]		
Subgroups	< 1 d/w	1–2 d/w	3–5 d/w	6–7 d/w	Weak	Moderate	Strong
N	269,428	30,930	27,853	145,804	59,252	71,298	74,037
Age (years, SE)[b]	53.2 (0.0)	49.2 (0.1)	49.1 (0.1)	48.7 (0.0)	51.4 (0.0)	49.8 (0.0)	48.5 (0.0)
Male[c]	38.7 (0.1)	46.0 (0.3)	46.2 (0.3)	43.2 (0.2)	38.3 (0.2)	44.2 (0.2)	43.8 (0.2)
Married	90.7 (0.1)	90.6 (0.2)	90.8 (0.2)	91.6 (0.1)	91.6 (0.1)	91.7 (0.1)	91.9 (0.1)
Highest education level							
Primary school and below	52.3 (0.1)	48.5 (0.2)	47.7 (0.3)	49.2 (0.1)	50.5 (0.2)	50.5 (0.2)	52.3 (0.2)
Middle or high school	42.1 (0.1)	44.9 (0.3)	46.3 (0.3)	45.8 (0.1)	43.7 (0.2)	44.3 (0.2)	43.6 (0.2)
College and above	5.6 (0.0)	6.5 (0.1)	6.0 (0.1)	5.0 (0.1)	5.7 (0.1)	5.1 (0.1)	4.1 (0.1)
Household income							
<10000	30.1 (0.1)	27.6 (0.2)	27.3 (0.2)	26.4 (0.1)	33.3 (0.2)	34.5 (0.1)	33.1 (0.2)
10000–19999	28.6 (0.1)	27.0 (0.3)	26.9 (0.3)	29.3 (0.2)	29.5 (0.2)	30.3 (0.2)	29.1 (0.2)
>20000	41.3 (0.1)	45.4 (0.2)	45.7 (0.3)	44.3 (0.2)	37.3 (0.2)	35.2 (0.2)	37.8 (0.2)
Occupation							
Manual work	58.5 (0.1)	59.6 (0.2)	59.2 (0.2)	57.5 (0.1)	65.1 (0.2)	63.0 (0.2)	64.8 (0.2)
Non-manual work	12.8 (0.1)	14.1 (0.2)	14.1 (0.2)	14.2 (0.1)	13.5 (0.1)	13.4 (0.1)	12.7 (0.1)
Not working	28.7 (0.1)	26.3 (0.2)	26.7 (0.2)	28.3 (0.1)	21.4 (0.2)	23.6 (0.1)	22.5 (0.1)

SE: standard error.
Values are percentages or means of participants adjusted for age, sex and region unless specified.
[a]Among those consuming spicy food ≥ 1 d/w.
[b]Adjusted for sex and region.
[c]Adjusted for age and region.

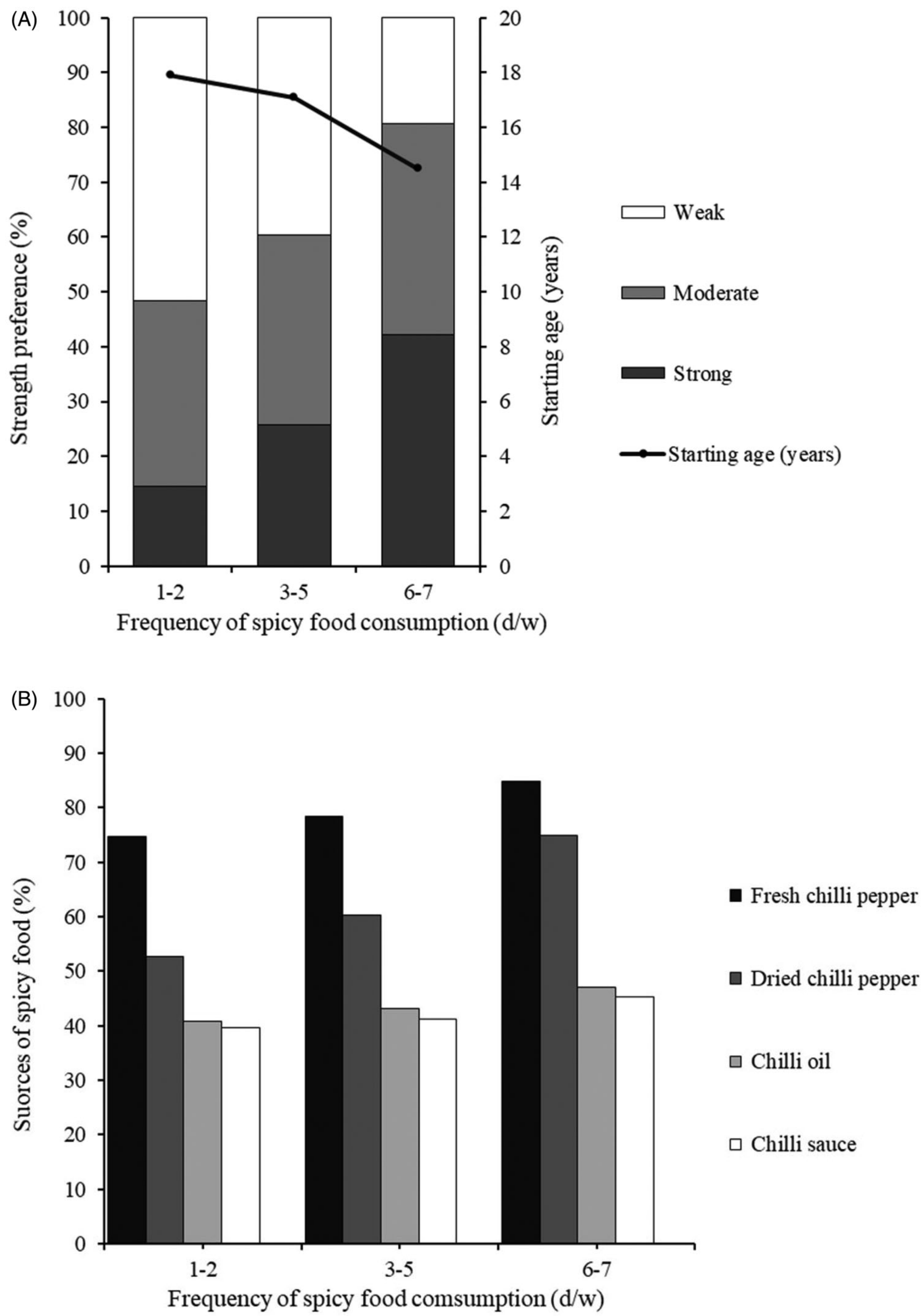

Figure 1. Characteristics of spicy food consumption metrics according to the weekly intake frequency. (A) Pungency degree and age of starting habitual spicy food consumption. (B) Sources of spicy food. All values were adjusted for age, sex, region, household income and education. *p* value for linear trend test for starting age, pungency degree and sources of spicy food across frequency of spicy food consumption were all $<$0.001.

Figure 1(A)). Fresh chilli pepper, dried chilli pepper, chilli oil and chilli sauce were successively top four most popular spicy food in all groups, and the percentages of each source were positively correlated with its frequency (p for trend < 0.001, Figure 1(B)).

Daily spicy food consumers consumed the most poultry (102.1 g/w) and preserved vegetables (179.5 g/w) compared with other categories. Also, participants who preferred stronger pungency degree were more likely to consume meat, fresh vegetables, fresh fruits, soya products and had higher daily energy intake, but less likely to consume milk and soymilk (P for trend < 0.001, Table 2). The higher frequency of spicy food consumption or stronger pungency degree, the higher proportion of snacking (from 23.1 to 30.7%, and from 28.4 to 31.8%, respectively) and eating deep-fried

Table 2. Characteristics of dietary intakes according to spicy food consumption in the resurvey ($n = 21,107$).

	Frequency				Pungency degree[a]		
Subgroups	<1 d/w	1–2 d/w	3–5 d/w	6–7 d/w	Weak	Moderate	Strong
N	13,422	1,085	814	5,786	3,639	3,208	839
Dietary intakes (g/w, SE)							
Rice	1438.0 (6.4)	1390.5 (21.0)	1451.3 (24.3)	1459.3 (10.9)	1375.6 (11.5)	1380.9 (12.1)	1325.6 (23.3)
Wheat	698.4 (4.8)	638.3 (15.5)	679.1 (18.0)	694.9 (8.1)	756.7 (9.2)	781.2 (9.7)	789.0 (18.7)
Grains	244.7 (3.0)	256.3 (9.8)	244.9 (11.4)	246.7 (5.1)	165.9 (4.7)	157.8 (4.9)	159.0 (9.4)
Meat	369.4 (2.9)	374.5 (9.4)	350.0 (10.9)	419.2 (4.9)[d]	427.6 (5.8)	448.8 (6.2)	504.8 (11.9)[d]
Fish	148.1 (2.4)	165.1 (7.9)	161.5 (9.2)	166.3 (4.1)[d]	133.0 (3.9)	136.2 (4.1)	151.6 (7.8)
Poultry	81.9 (1.2)	84.8 (4.4)	85.6 (5.1)	102.1 (2.3)[d]	88.2 (2.6)	89.5 (2.8)	99.6 (5.3)
Fresh vegetables	1635.9 (8.5)	1613.8 (27.6)	1556.9 (32.0)	1692.2 (14.3)[d]	1567.5 (15.2)	1603.3 (16.1)	1783.4 (30.9)[d]
Preserved vegetables	122.2 (1.8)	145.3 (5.8)	151.7 (6.7)	179.5 (3.0)[d]	159.7 (3.7)	165.2 (4.0)	173.6 (7.6)
Fresh fruits	1635.9 (8.5)	1613.8 (27.6)	1556.9 (32.0)	1692.2 (14.3)[d]	1567.5 (15.2)	1603.3 (16.1)	1783.4 (30.9)[d]
Soya products	132.1 (1.7)	141.9 (5.7)	139.7 (6.6)	157.7 (2.9)[d]	138.5 (3.1)	143.9 (3.3)	158.5 (6.4)[d]
Yoghurt	54.4 (2.1)	52.9 (6.8)	54.5 (7.8)	66.5 (3.5)[d]	64.2 (4.1)	54.8 (4.3)	56.1 (8.3)
Other dairy foods	5.7 (0.6)	6.7 (1.8)	8.1 (2.1)	7.6 (0.9)	8.7 (1.2)	5.5 (1.3)	7.4 (2.5)
Energy intake (kcal/d, SE)[b]	1505.0 (4.8)	1477.7 (15.6)	1496.7 (18.1)	1578.7 (8.1)[d]	1511.0 (9.1)	1533.7 (9.6)	1566.8 (18.5)[d]
Beverage intakes (mL/w, SE)							
Soymilk	118.1 (3.5)	145.4 (11.5)	114.2 (13.4)	128.5 (6.0)	132.5 (6.4)	112.7 (6.8)	106.9 (13.0)[d]
Milk	204.5 (4.5)	200.9 (14.7)	206.6 (17.0)	193.7 (7.6)	194.3 (7.9)	159.8 (8.3)	152.9 (15.9)[d]
Other drinks	65.9 (3.6)	103.1 (11.9)	87.3 (13.7)	126.6 (6.1)[d]	119.6 (8.1)	113.7 (8.6)	131.1 (16.5)
Unhealthy eating habits (%, SE)[c]							
Snacking	23.1 (0.4)	29.5 (1.4)	30.0 (1.6)	30.7 (0.7)[d]	28.4 (0.8)	31.9 (0.8)	31.8 (1.6)[d]
Skipping breakfast	8.8 (0.2)	10.7 (0.9)	16.2 (1.3)	11.9 (0.5)[d]	11.2 (0.5)	10.3 (0.6)	11.2 (1.0)
Deep-fried foods	5.3 (0.2)	9.2 (0.8)	9.4 (1.0)	11.9 (0.6)[d]	8.5 (0.4)	10.8 (0.6)	12.2 (1.2)[d]
Western fast foods	0.5 (0.1)	0.4 (0.2)	0.6 (0.3)	0.8 (0.2)[d]	0.6 (0.1)	0.8 (0.2)	1.3 (0.5)
Any above	33.1 (0.4)	41.9 (1.5)	46.8 (1.7)	44.9 (0.8)[d]	40.4 (0.8)	44.5 (0.9)	45.9 (1.7)[d]
Condiments intake							
Salty preference (%, SE)	22.8 (0.4)	26.7 (1.3)	33.0 (1.6)	38.9 (0.8)[d]	26.1 (0.7)	37.4 (0.9)	50.2 (1.7)[d]
Salt (g/d, SE)	29.6 (0.2)	31.0 (0.7)	30.7 (0.9)	32.0 (0.4)[d]	34.2 (0.5)	33.7 (0.5)	35.3 (1.0)
Soy sauce (mL/d, SE)	16.7 (0.2)	17.7 (0.6)	17.5 (0.7)	19.0 (0.3)[d]	16.7 (0.4)	17.3 (0.4)	17.8 (0.8)
Cooking oil (mL/d, SE)	113.0 (0.8)	119.6 (2.7)	114.2 (3.4)	121.8 (1.5)[d]	126.7 (1.7)	127.8 (1.9)	127.9 (3.5)

SE: standard error.
Values are percentages or means of participants adjusted for age, sex, region, household income and education.
[a]Among those consuming spicy food ≥ 1 d/w.
[b]kcal/d, kilocalorie per day.
[c]Defined as snacking, skipping breakfast, eating deep-fried foods or eating western-type fast foods ≥ 1 d/w.
[d]p for trend < 0.05.

Table 3. Characteristics of lifestyle behaviours according to spicy food consumption ($n = 474,015$).

	Frequency (%, SE)				Pungency degree (%, SE)[a]		
Subgroups	<1 d/w	1–2 d/w	3–5 d/w	6–7 d/w	Weak	Moderate	Strong
Tea consumption							
Never	37.6 (0.1)	31.1 (0.2)	30.1 (0.2)	29.5 (0.1)	23.8 (0.1)	22.1 (0.1)	21.0 (0.2)
Occasionally	32.2 (0.1)	33.1 (0.3)	33.6 (0.3)	31.4 (0.2)[c]	33.8 (0.2)	33.1 (0.2)	32.4 (0.2)[c]
1–5 d/w	6.7 (0.1)	10.2 (0.2)	9.4 (0.2)	7.8 (0.1)[c]	10.7 (0.2)	9.8 (0.1)	8.2 (0.1)
6–7 d/w	23.5 (0.1)	25.6 (0.2)	26.9 (0.2)	31.3 (0.1)[c]	31.8 (0.2)	34.9 (0.2)	38.4 (0.2)[c]
Alcohol consumption							
Never	51.7 (0.1)	44.1 (0.2)	42.4 (0.2)	39.9 (0.1)	49.2 (0.2)	45.1 (0.2)	41.7 (0.2)
Occasionally	36.5 (0.1)	39.4 (0.3)	39.2 (0.3)	38.0 (0.2)[c]	36.2 (0.2)	37.0 (0.2)	36.3 (0.2)[c]
1–5 d/w	4.8 (0.1)	7.2 (0.1)	7.6 (0.1)	7.8 (0.1)[c]	6.3 (0.1)	7.1 (0.1)	7.6 (0.1)[c]
6–7 d/w	7.1 (0.0)	9.3 (0.1)	10.8 (0.2)	14.3 (0.1)[c]	8.3 (0.1)	10.8 (0.1)	14.4 (0.1)[c]
Smoking							
Never	63.7 (0.1)	60.9 (0.2)	59.9 (0.2)	59.5 (0.1)	60.2 (0.1)	58.9 (0.1)	56.8 (0.1)
Occasionally	6.2 (0.1)	6.2 (0.1)	5.9 (0.1)	4.9 (0.1)[c]	6.8 (0.1)	5.8 (0.1)	5.0 (0.1)
Ex-regular	5.6 (0.0)	5.3 (0.1)	5.4 (0.1)	4.9 (0.1)[c]	4.9 (0.1)	4.6 (0.1)	4.2 (0.1)[c]
Current regular	24.5 (0.1)	27.5 (0.2)	28.7 (0.2)	30.7 (0.1)[c]	28.1 (0.2)	30.7 (0.1)	34.0 (0.1)[c]
Physical activity[b]							
Low	33.4 (0.1)	33.0 (0.2)	32.7 (0.2)	33.3 (0.1)	29.1 (0.2)	28.6 (0.1)	29.6 (0.1)
Medium	33.3 (0.1)	34.2 (0.3)	34.1 (0.3)	33.1 (0.2)	35.6 (0.2)	36.4 (0.2)	35.9 (0.2)
High	33.3 (0.1)	32.9 (0.2)	33.2 (0.2)	33.6 (0.1)[c]	35.3 (0.2)	35.0 (0.2)	34.5 (0.2)[c]

SE: standard error.
Values are percentages or means of participants adjusted for age, sex, region, household income and education.
[a]Among those consuming spicy food ≥1 d/w.
[b]Low physical activity was defined as <13.68 MET-h/d in male or < 12.81 MET-h/d in female, medium was ≥ 13.68 and < 28.73 MET-h/d in male or ≥ 12.81 and <24.6 MET-h/d in female, high was ≥28.73 MET-h/d in male or ≥ 24.6 MET-h/d in female (sex-specific tertiles amount of exercises).
[c]p for trend <0.05.

Table 4. Details of lifestyle behaviours according to spicy food consumption among weekly tea/alcohol drinkers and current smokers.

	Frequency (%, SE)				Pungency degree (%, SE)[a]		
Subgroups	<1 d/w	1–2 d/w	3–5 d/w	6–7 d/w	Weak	Moderate	Strong
Weekly tea drinker							
N	68,257	10,474	9,380	71,736	19,671	26,481	45,438
Burning-hot tea	14.7 (0.1)	11.4 (0.2)	13.6 (0.3)	15.9 (0.2)	13.0 (0.2)	14.2 (0.2)	17.2 (0.2)
Strong tea	8.9 (0.1)	9.8 (0.2)	11.4 (0.3)	13.8 (0.2)	6.3 (0.1)	8.9 (0.1)	10.6 (0.2)
Tea-leaves (g/d)	3.6 (0.0)	3.7 (0.0)	4.0 (0.0)	4.3 (0.0)	3.3 (0.0)	3.8 (0.0)	3.8 (0.0)
Age of start	28.9 (0.1)	28.2 (0.1)	27.8 (0.1)	27.1 (0.1)	26.0 (0.1)	24.8 (0.1)	24.1 (0.1)
Weekly alcohol drinker							
N	35,201	6,094	5,954	25,101	10,666	13,933	12,550
Unhealthy drinker[b]	70.3 (0.3)	72.3 (0.6)	74.6 (0.5)	78.1 (0.3)	71.9 (0.5)	76.5 (0.4)	81.3 (0.4)
Daily morning drinker	3.4 (0.1)	3.5 (0.3)	4.2 (0.3)	5.5 (0.2)	3.6 (0.2)	4.6 (0.2)	6.8 (0.2)
Alcohol (g/d)	49.3 (0.2)	50.5 (0.5)	53.2 (0.5)	57.2 (0.3)	50.3 (0.4)	54.8 (0.3)	61.2 (0.4)
Age of start	29.6 (0.1)	29.5 (0.1)	29.3 (0.1)	28.6 (0.1)	28.9 (0.1)	28.3 (0.1)	27.3 (0.1)
Current smoker							
N	80,109	11,052	10,228	51,910	20,217	25,915	27,058
Heavy smoker[c]	6.4 (0.1)	6.6 (0.3)	7.8 (0.3)	8.8 (0.2)	6.8 (0.2)	8.3 (0.2)	10.2 (0.2)
Cigarette (No./d)	17.3 (0.0)	17.5 (0.1)	18.1 (0.1)	18.8 (0.1)	17.7 (0.1)	18.6 (0.1)	19.8 (0.1)
Age of start	22.8 (0.0)	22.7 (0.1)	22.6 (0.1)	22.5 (0.0)	22.7 (0.1)	22.5 (0.1)	22.0 (0.1)

SE: standard error.
Values are percentages or means of participants adjusted for age, sex, region, household income and education.
[a]Among those consuming spicy food $\geq$ 1 d/w.
[b]Defined as consuming alcohol $>$ 15 g/d (female) or $>$30 g/d (male).
[c]Defined as smoking $\geq$ 40 cigarettes per day.
p value for linear trend test for all subgroups across frequency of spicy food consumption as well as pungency degree were $<$0.001.

foods (from 5.3 to 11.9%, and from 8.5 to 12.2%, respectively). In addition, the preference for salty taste increased from 22.8% in non-spicy-food consumers to 38.9% in daily consumers, and from 26.1% in those preferred weak pungency degree to 50.2% in those preferred strong pungency degree.

Table 3 showed differences in lifestyle behaviours across spicy food consumption categories. Individualswith higher frequency of spicy food intake also had a higher proportion in daily tea/alcohol consumption (from 23.5 to 31.3%, and from 7.1 to 14.3%, respectively) and current smoking (from 24.5 to 30.7%). Similar correlations were found with stronger pungency degree. However, negative correlations were found between pungency degree and high-level physical activity.

Further analysis among weekly tea/alcohol drinkers and current regular smokers, showed that participants with higher frequency of spicy food consumption or preference for stronger pungency degree were more likely to prefer strong tea, drink alcohol exceed the healthy amount, drink alcohol in the morning every day and smoke at least 40 cigarettes per day (Table 4). Positive correlations were found between pungency degree, not spicy food intake frequency, with drinking burning-hot tea, which increased from 13.0% in those preferred weak pungency degree to 17.2% in those preferred strong pungency degree. Frequency of spicy food consumption and pungency degree were found to be positively correlated the amount of tea leaves, alcohol and cigarettes consumed each day, but negatively correlated with the age of starting tea/alcohol drinking and smoking (all *P* for trend $<$ 0.001).

Discussion

In this study conducted among the Chinese adults, the spicy food consumption, in term of its frequency and pungency degree, showed clear population variations. People with different level of spicy food consumption had different dietary habits and lifestyle behaviours.

In line with the China Health and Nutrition Survey (CHNS) (Shi et al. 2017; He et al. 2019), which included 27,447 individuals among 12 regions across China (Zhang et al. 2014), we found younger generation prefer spicy food than the older, but no clear difference in gender, education and income distribution. Unfortunately, the CHNS didn't go further to describe a full picture of spicy food consumption, such as marital status and occupation.

Spicy food intake frequency was found positively correlated with poultry, preserved vegetables and preference for salty taste, as well as snacking and eating deep-fried foods. The possible hypothesis may be that deep-fried foods were more likely to be served with chilli powder in China. Previous studies reported mixed results on salt intake. The CHNS (He et al. 2019) discovered that those who consumed spicy food $>$5 d/w used more salt compared to non-consumers. But a study by Li et al. (2017) found the opposite. Besides, we found that spicy food consumers also used more cooking oil than non-consumers, consistent with the CHNS (Shi et al. 2017) which found the non-consumers ate the least fat on average. Pungency degree was negatively related to intakes of milk and soymilk. However, a study found that milk can mitigate the oral burn caused by capsaicin, and it's more effective than seltzer water and cola (Nolden et al. 2019).

Partly consistent with previous studies (Dovey et al. 2016; Park et al. 2017; He et al. 2019), we found that spicy food consumption metrics, including frequency and pungency degree, were clustered with diverse factors, such as weekly tea/alcohol drinking, current tobacco smoking and different dietary habits. Several studies have recently reported the health effects of spicy food on various diseases (McCarty et al. 2015; Chen et al. 2017b; Zhao et al. 2020). However, such associations could be modified by these lifestyle factors according to this study. For example, a study only adjusted for age and sex found that spicy food preference was negatively correlated with diabetes prevalence (Zhao et al. 2020), and another prospective study found the same result, but the result was found statistically insignificant after further adjustment for smoking, alcohol consumption, physical activity and BMI (Lv et al. 2015). In addition, details of these lifestyle behaviours differed across spicy food intake frequency and pungency degree, which might affect health outcomes in different ways. Wang et al. (2007) found that high intake of chilli and salt, tobacco smoking and alcohol drinking were possible risk effects for oesophageal cancer, while green tea drinking showed possible protective effect. However, a prospective study in this same population found that combining either alcohol drinking or smoking, drinking tea with high-temperature showed greater risk for oesophageal cancer than drinking hot tea alone (Chen et al. 2017a). These mixed results suggest that the confounding/modifying potency of other dietary habits, tea/alcohol drinking and smoking as well as the details of these behaviours should be taken into consideration while assessing the health effects of spicy food consumption.

To the best of our knowledge, this study is the first comprehensive description of the populational distribution of spicy food consumption among Chinese adults, and explored its correlations with lifestyle behaviours. However, some limitation merits to mention. First of all, the CKB study recruited participants in ten geographically diverse regions, but still not a representative sample of the Chinese population (Li et al. 2012). Therefore, one must be cautious when extrapolating our results to a national context. Secondly, detailed information on spicy food consumption and dietary habits was self-reported, which might lead to recall bias. Besides, our study did not collect data on the accurate amount of spicy food intake and cooking methods, which could bring more information to this study.

Conclusion

In a large population-based cohort, significant differences existed in lifestyle characteristics according to spicy food consumption frequency and pungency degree in the Chinese population. More consideration should be taken when examining the health effect of spicy food consumption.

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Author contributions

Qiaorui Wen drafted the manuscript. Qiaorui Wen and Yuxia Wei analysed the data. Yu Guo, Zheng Bian, Yan Chen and Liya Shi collected the data. Bian Zheng, Ling Yang and Yiping Chen were involved in data cleaning. Canqing Yu, Jun Lv and Huaidong Du interpreted the results and contributed to the critical revision of the manuscript for important intellectual content. Zhengming Chen and Liming Li are the study guarantors. Liming Li, Zhengming, Canqing Yu and Junshi Chen designed the study. All authors have read and approved the final version of the manuscript.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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Data availability statement

The dataset for this study is available at www.ckbiobank.org, as well as the access policy and procedures.

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