The Roles of Alcohol Drinking and Dietary Factors in the U-shaped Relationship Between Cigarette Smoking and Body Mass Index in Middle-aged and Elderly Chinese Rural Adults: Cross-sectional Study

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Abstract

Background To investigate the relationship between smoking behaviour and BMI, from the perspective of the roles of alcohol drinking and dietary factors in a middle-aged and elderly Chinese rural population. Methods The authors analysed cross-sectional data from 10,837 middle-aged and elderly Chinese rural adults aged from 35 to 75 years who in 2011-2017 completed a questionnaire that included questions on demographic characteristics, dietary intake, and detailed smoking and drinking status. Results Current smokers tended to have a lower BMI and consume foods less frequently (except coriander, onion, garlic, hawthorn and fermented bean curd) than non-smokers. The relationship between smoking amount and the risk of being overweight or obese was U-shaped, and the trends were also similar by stratum of baseline age groups (all p for interaction 0.001). Heavy smokers tended to have drinking habits, whereas drinking was found to be associated with increased risk of being overweight or obese (all p for trend 0.001). In addition, despite the lower risk of being overweight or obese for current smokers, the normal weight individuals were found to have the minimum smoking amount. Conclusions This study suggests that cigarette smoking may cause suppression of appetite but smokers tend to have other unhealthy habits relating to increased body weight, and highlights that dietary factors and alcohol use play important roles in the U-shaped relationship between smoking behaviours and BMI in the middle-aged and elderly Chinese rural population. Additionally, people rarely or never smoke may be more likely to be within a normal BMI range than heavy smokers.

Background

WHAT IS ALREADY KNOWN ON THIS TOPIC

Smokers have lower BMI on average than non-smokers, especially in adolescents and young adults.

Up to a certain point, smoking is associated with a decreased BMI, but beyond this, heavy smokers weigh more than light smokers because BMI starts increasing.

WHAT THIS STUDY ADDS

In the middle-aged and elderly Chinese rural population, smokers also have lower BMI on average than non-smokers, which is a good addition to the previous studies.

Smokers tend to consume less foods than non-smokers, except certain types of strongly flavoured foods, because smoking causes suppression of appetite, and heavy smokers tend to drink more alcohol.

The important roles of dietary factors and alcohol consumption may be responsible for the U-shaped relationship between smoking behaviour and BMI.

Individuals rarely or never smoke have higher BMIs than current smokers but are typically more likely to be within a normal BMI range than smokers, who are typically at more extreme ends of the spectrum.

From the long-stemmed pipe, snuff, water pipe to the hand-rolled cigarettes and finally the manufactured cigarettes, the history of tobacco use in China started from sixteenth century, since the introduction of tobacco into China from the New World[1]. The history of tobacco may be a fascinating story of a commodity that became a symbol of modern mass consumerism, but the health and economic burden of smoking-related ill health should not be overlooked. Smoking is one of the most important causes of avoidable death and illness in China. With a population of nearly 1.4 billion, China is currently the largest tobacco producer and consumer worldwide, bearing a high morbidity and mortality attributable to tobacco smoking[2]. Interestingly, many old epidemiological studies have indicated that tobacco smoking is inversely associated with body weight, while smoking cessation is likely to result in weight gain[3-7].

In fact, papers reporting that smoking reduced body weight started to appear more than a hundred years ago[5], but relative studies began very late and detailed researches aiming at analysing the relationship between tobacco use and body weight in general population have rarely been studied in the last few decades. Previous studies mainly investigated the association between tobacco use and Body Mass Index (BMI) in adolescents and young adults, because some of them may smoke for intentional weight loss, especially young girls[8-10]. It has been reported that female adolescents may start smoking and continuing with this habit for purposes of weight control and weight loss[11]. These studies, however, have focused on a particular demographic (young people) and there is, in our view, a significant gap as a result. Of note, cigarette smoking may result in acute suppression of appetite via actions of nicotine[12]. People are probably aware of its appetite-suppressing actions[5], but the conclusion is inconsistent in some other studies[13, 14]. To our knowledge, no study has yet examined these specific relationships in a middle-aged and elderly Chinese rural population detailedly. In China, rural residents living in villages typically have very simple lifestyle and relatively stable dietary pattern, owing to the non-pluralistic societal environment and being generally low socio-economic class without much variation. Therefore, this study may be a good addition to the previous studies as it sampled a relatively unstudied sample group, which provides additional data.

Additionally, it was reported that smoking status had positive associations with alcohol drinking status, suggesting that heavy smokers are likely to have heavy use of alcohol[15, 16]. Alcohol has a caloric value of 7.1 kcal (29 kJ) per gram and therefore becomes a nontrivial energy source, and alcohol intake is also positively associated with intake of red meat, poultry and high-fat diet, which are possibly associated with weight gain and the development of obesity[16, 17]. Many cross-sectional studies and some prospective cohort studies have indicated that alcohol consumption is positively associated with weight gain and thus a risk factor for obesity[18-22], but some other epidemiological studies reported inconsistent results of null and inverse associations[23, 16, 24, 25].

Therefore, clear cause-and-effect relationships among tobacco use, alcohol consumption and BMI are not apparent so far based on the mixed and conflicting nature of available evidence. Meanwhile, detailed study on these topics is required and needs to be updated as most of the previous studies were conducted several decades ago. Given that excessive use of tobacco and alcohol and the burden of obesity are of public health concern, the aim of this study is to provide a detailed update on the association between tobacco smoking and BMI, based on their relationships with alcohol drinking status and dietary factors in the relatively unstudied sample of middle-aged and elderly Chinese rural population.

Methods

Study population

Subjects included in the current study were selected from participants in the database of the Early Diagnosis and Early Treatment Project of Esophageal Cancer (EDETPEC) from January 2011 to December 2017, which was supported by the government and Cancer Foundation of China for benefiting rural residents[26]. In the present study, 10,837 middle-aged and elderly Chinese rural adults (6,714 female and 4,123 male) aged from 35 to 75 and free of cancers and precancerous lesions were included. Of the 10,837 population, 3007 people were current smokers and 7830 people were non-smokers. The study was approved by the Institutional Review Board of Southeast University Zhongda Hospital (no. 2012ZDIIKY19.0), in accordance with the Declaration of Helsinki. All subjects signed written informed consent in the study.

Socio-demographic and anthropometric data

A questionnaire was used to collect socio-demographic data during the face-to-face interviews. Gender (male, female), age (35-50, 51-60, 61-75), education level (illiteracy, primary school, middle/high school, college/university) and family annual income per capita (≤5000, 5001-10000, 10001-15000, ≥15001 RMB) were obtained through the questionnaire at baseline and then classified into the categories listed in the above brackets.

Weight and height were measured using a conventional stadiometer and scale when subjects were in lightweight clothes without any shoes on. BMI was calculated as weight in kilograms divided by the square of the height in meters. Referring to the cutoff values for Chinese population recommended by the National Health and Family Planning Commission of the People's Republic of China[27], BMI was categorized as underweight if 18.5 kg/m^2, normal if between 18.5 kg/m^2 and 23.9 kg/m^2, overweight if between 24.0 kg/m^2 and 27.9 kg/m^2, and obese if ≥28.0 kg/m^2.

Assessment of tobacco and alcohol use

Smoking and drinking behaviour parameters were obtained by questionnaire during the interview at recruitment. Subjects were asked what volume (mL) of alcoholic beverages they consumed, on average, per day. Alcoholic beverages included beer, liquors, and wine. Alcohol units consumed per day (1 unit is 10ml of pure alcohol[28]) was calculated according to the common alcoholicity of the popular alcoholic beverages in China, assuming ethanol of 40 mL (4 units) for 100 mL liquor, 4 mL (0.4 unit) for 100 mL beer, and 10 mL (1 unit) for 100 mL wine. Additionally, other details of tobacco and alcohol use were also collected, including the average number of cigarettes smoked per day (1 pack has 20 cigarettes), duration of smoking/drinking habit (years) and age at which they started smoking/drinking. Cumulative consumption of tobacco/alcohol (pack-years/unit-years) was calculated as well.

Assessment of dietary intake

A validated qualitative food frequency questionnaire (FFQ) was performed to estimate dietary factors, covering 9 specific food categories (vegetables, fruits, nuts, cereals, bean food, animal product, fried food, pickled food and food made with yeast) and 29 specific food items that are commonly consumed in rural regions. Given that the seasonality would influence consumption frequency throughout the year, the FFQ accounted for the seasonality of some foods to ensure the accuracy of the calculation of frequency. Thus, subjects were asked how often they consumed the foods per week/per month/per year and how long, in months, they would consume this food yearly (e.g. 12 months for year round food, 2-3 months for very seasonal food). Then the data was standardized into ‘times per week’ averaged out over the course of a single year. Four frequency categories ranging from ‘never’, ‘less than once a week’, ‘once a week or more but less than three times a week’ to ‘three or more times a week’ were applied to the statistical analysis finally.

Statistical analysis

Continuous variables were expressed as the mean ± standard deviation (SD). Student's t test was conducted to evaluate the significance of differences in the body size parameters between smokers and non-smokers. Tamhane's T2 post-hoc test was performed to evaluate the significance of differences in the smoking parameters among the four BMI categories in subjects after ranking variables within cases, as this test is appropriate in situations where the variance and/or sample size of groups is unequal. Unconditional univariate and multivariate logistic regression analyses were conducted to compute crude and adjusted odds ratios (OR) and corresponding 95% confidence intervals (CI), respectively. Confounders including gender, age, BMI, education level, family annual income per capita, number of cigarettes per day, alcohol units consumed per day and consumptions of total vegetables, fresh fruits and meats were adjusted when appropriate. The joint effects of age groups and three smoking behaviour parameters on the risk of being overweight or obese by dividing the study subjects into 9 or 12 groups were further assessed. Interaction was examined using multivariate logistic regression model. Meanwhile, tests for linear trends were carried out by assigning the median value of each category of smoking and drinking behaviour parameters and BMI as a continuous variable in the models.

Questionnaire data was double-entered and validated using Epidata version 3.1 and then transformed into Microsoft Excel file. Analyses were carried out with the use of IBM SPSS Statistics version 22.0 (SPSS Inc., Chicago, IL, USA). Figures were created by GraphPad Prism 7.04 (GraphPad Software Inc., San Diego CA, USA) and Microsoft Excel 2007 (Microsoft Inc., Redmond, WA, USA). All reported p values were 2-sided, and a p-value □ 0.05 was considered statistically significant.

Results

Table 1 and table 2 describe the distribution of BMI and smoking behaviour variables of the study subjects. As shown in table 1, current smokers weigh, on average, less than non-smokers and are likely to have a lower BMI. The mean data shown in table 2 reports that underweight subjects started smoking at the youngest age, and had the highest number of cigarettes smoked per day, the longest duration of smoking and largest cumulative amount of smoking among the four BMI categories. However, it is interesting to find that subjects with normal weight had the lowest mean levels of smoking status mentioned above.

As shown in figure 1, the analysis assessed the ORs for being overweight or obese in a multivariate logistic regression model in which combinations of age groups and smoking behaviour parameters were used to reclassify the subjects into 9 or 12 subgroups. Compared with non-smokers aged 35-≤50 years (reference), smokers aged ≥ 61 years who smoked 10-□20 cigarettes (OR = 0.51; 95% CI, 0.41-0.63), or had 15-□30 pack-years of cumulative amount of smoking (OR = 0.49; 95% CI, 0.38-0.64), or started smoking at ≥ 25 years old (OR = 0.56; 95% CI, 0.48-0.66) show the lowest ORs for being overweight or obese. In addition, figure 1 also suggests that the OR for being overweight or obese had a decreasing trend along with the increases of the baseline age group and/or age at started smoking. However, it can be found that there could be a U-shaped relationship between the number of cigarettes smoked per day/cumulative amount of smoking and the OR for being overweight or obese, with 10-□20 cigarettes smoked per day and 15-□30 pack-years being the lowest ORs (except the one which aged 51-≤60 and had 15-□30 pack-years). The trends in risk of being overweight or obese with the changes of smoking behaviour parameters were also similar by stratum of baseline age groups (all *p* for interaction □ 0.001).

On the other hand, figure 2 illustrates the analysis assessing the ORs for being smokers according to the four BMI categories in a multivariate logistic regression model. The OR for being smokers showed a decreasing trend along with the increase of the BMI in total subjects (*p* for trend □ 0.001), as well as in the subgroups of male (*p* for trend □ 0.001) and female (*p* for trend = 0.005). Statistically, figure 2 (b) suggests that the data of female were more significant than those of male, and the trend was more remarkable.

Figure 3 provides a visual representation of the differences in dietary intake frequency between current smokers and non-smokers, with model adjusted for gender, age, BMI, education level, annual income and alcohol units consumed per day. It can be easily seen that non-smokers tended to consume most foods

more frequently than smokers, whereas smokers may be more likely to consume coriander, onion, garlic, hawthorn and fermented bean curd frequently.

Adjusted data in table 3 indicates strong positive associations between alcohol drinking behaviour parameters and risk of being overweight or obese, as the statistically significant increasing trend can be found in alcohol units consumed per day, duration of drinking, earlier age at starting drinking, as well as cumulative amount of drinking (all p for trend < 0.001). In addition, consumptions of liquor and beer were significantly associated with 70% (p < 0.001) and 48% (p = 0.002) increased risks of being overweight or obese, respectively, whereas no statistical significance was found in wine consumption (p = 0.231).

As can be seen from table 4, adjusted results show strong positive associations between smoking behaviour parameters and risk of becoming a drinker. The statistically significant increasing trend can be found in number of cigarettes smoked per day, duration of smoking, earlier age at starting smoking, as well as cumulative amount of smoking (all p for trend < 0.001).

Discussion

Based on comprehensive data from 10,837 middle-aged and elderly Chinese rural individuals, this cross-sectional study provided evidence that current smokers tended to have a lower BMI than non-smokers and thus were less likely to be overweight or obese, but the relationship might be U-shaped between amount of smoking and risk of being overweight or obese. Interestingly, individuals with normal weight would have the lowest levels of smoking behaviours among the four BMI categories, including the oldest age at starting smoking, the lowest number of cigarettes smoked per day, the shortest duration of smoking and the minimum cumulative amount of smoking. Additionally, this study also found that smokers, especially heavy smokers, were more likely to be drinkers and eat less when compared with non-smokers, whereas alcohol drinking behaviours were positively associated with the risk of being overweight or obese. These results highlighted the roles of alcohol drinking behaviour and dietary factors in influencing the relationship between smoking status and BMI, which could have implications for public health interventions aiming at reducing the burdens from weight issues and harmful use of alcohol and tobacco.

Relation to published evidence

A previous epidemiological study also found that young American adults aged less than 30 years who were trying to lose weight were more likely to smoke[29]. However, the mechanism that smoking is associated with reduced body weight is still complex and remains incompletely understood. Basically, cigarette smoking is often thought to have appetite-suppressing actions and therefore control weight[12, 10]. As shown in figure 3, it is obvious that smokers tended to eat less than non-smokers, including most foods of vegetables, fruits, nuts, cereals, bean food, animal product, fried food, pickled food and food made with yeast. However, they may consume more coriander, onion, garlic, hawthorn and fermented bean curd, which are generally considered as the flavorants or foods with a strong flavour having positive effects on appetite or digestion [30-32]. Therefore, it can be suggested that cigarette smoking may

negatively influence subjects' appetite, and result in lower consumption of food and consequent reduced body weight. Previous study held that on the one hand, cigarette smoking might serve as a behavioral alternative to eating, and on the other hand, nicotine in cigarettes may increase the resting metabolic rate while controlling the expected growth in food consumption in response to the growth in metabolic rate, which would tip the balance of caloric intake and daily energy expenditure[10]. Interestingly, the results shown in table 2 first reports that subjects with normal weight would have the lowest levels of smoking behaviours among the four BMI categories, which suggests that normal weight individuals may be more likely to have a relatively healthier lifestyle. In other words, subjects rarely or never smoked may be typically more likely to be within a normal BMI range than regular or heavy smokers, because they were less influenced by weight loss or weight gain caused by smoking or smoking cessation.

Among subjects a U-shaped relationship between the number of cigarettes smoked per day/cumulative amount of smoking and the OR for being overweight or obese can be found in figure 1, with 10-20 cigarettes smoked per day and 15-30 pack-years being the lowest ORs (except the one which aged 51-≤60 and had 15-30 pack-years). This finding is exactly consistent with several early studies, which have concluded that individuals smoked about 10-20 cigarettes per day were the leanest, with the trend being similar by stratum of baseline age groups[3, 33-40, 4]. Therefore, studies have reported that there is not just simply negative relationship between smoking amount and BMI or body weight, whereas the observed U-shaped relationship is by no means coincidental. Although this may seem paradoxical in consideration of the metabolic effects of smoking, it has been assumed that heavy smokers may be more likely to have some other unhealthy lifestyles and habits such as heavy alcohol use[4].

In order to verify the above hypothesis, the associations between alcohol use status and risk of being overweight or obese, and between smoking behaviour and alcohol drinking were also assessed. Adjusted results in table 3 illustrate strong positive associations between alcohol drinking behaviour parameters and risk of being overweight or obese, with the statistically significant increasing trends found in alcohol units consumed per day, duration of drinking, earlier age at starting drinking, as well as cumulative amount of drinking. Thus, alcohol use is likely to be a risk factor of overweight and obesity in this middle-aged and elderly Chinese rural population with a significant dose-response relationship. An updated research summarized cross-sectional, longitudinal and experimental studies examining the link between alcohol consumption and obesity also concluded that it is reasonable to say that use of alcohol may be a risk factor for obesity in some populations, likely based on a multitude of factors[41]. Furthermore, table 4 shows that heavy smokers were much more likely to be drinkers. Compared with non-smokers, heavy smokers smoked more than 20 cigarettes, experienced more than 35 years of smoking history, started smoking before 25 years old and had more than 30 pack-years of cumulative amount smoking were significantly associated with 4.88, 4.89, 4.96 and 5.17 times increased risk of becoming a drinker, respectively. By integrating the two parts of results, it is logical to draw that heavy smokers and smokers starting smoking early may be more likely to have the habit of alcohol drinking than light smokers, and past a certain point, the increase in consumption of alcohol and its related high-fat diet, which is highly calorific, offsets the appetite suppression effects of smoking, and this is what leads to the high BMI and obesity levels in heavy smokers, and explains the U-shaped relationship between smoking behaviours

and BMI. In addition, heavy drinking is usually accompanied by unhealthy dietary behaviour in China such as high intake of saturated fat and calories, because residents may consume alcoholic drinks frequently when having dinner or midnight snack together.

Strengths and limitations

A strength of the study was that it sampled a relatively unstudied demographic, and additionally, that demographic was one where potential variables were relatively stable, which means the sample group has the additional advantage of being relatively similar, thereby mitigating the impact of variables such as socio-economic status and diet, and improving the accuracy of the result. Furthermore, this study not only analysed the association between smoking and BMI, but also considered the roles of dietary factors and alcohol consumption, which may partly explain the U-shaped relationship between smoking and BMI: up to a certain point, smoking is associated with a decreased BMI, but beyond this, heavy smoking is associated with increased BMI and obesity.

Our study was limited by the possible recall bias brought by the questionnaire. The questionnaire collected the data of food frequency, but the information of portion size was unable to be obtained. In addition, this study was focused on current smokers, which means former smokers were excluded and not analysed. Furthermore, although dietary factors and alcohol use were taken into consideration, and several potential confounders were adjusted in the multivariate analyses, smokers and non-smokers may still differ with respect to other factors such as physical exercise. It should also be pointed out that cross-sectional study has limitations in establishing a causal association.

Conclusion And Implications

In summary, dietary factors and alcohol use were found to play important roles in the relationship between smoking behaviours and BMI in the middle-aged and elderly Chinese rural population. The lower BMI of light smokers may be due to the well-documented appetite suppressive impacts of smoking. This correlates with our data where we saw decreased consumption of most food types amongst smokers. Certain types of strongly flavoured foods were consumed more by smokers than non-smokers, but that this may be due to the affect that smoking has on taste perception. In addition, heavy smokers were more likely to have alcoholic drinking behaviour, which would be positively associated with the risk of becoming overweight or obese, and consequently, leading to the U-shaped relationship between amount of smoking and risk of being overweight or obese. In addition, non-smokers and light smokers may be more likely to be within a normal BMI range than regular and heavy smokers, who were typically at more extreme ends of the spectrum.

This study has significant implications for government health campaigns. Smoking is seen by some as a good way of maintaining a low BMI, but our findings show that smoking is associated with other poor lifestyle choices (in this case high alcohol consumption) which can have other negative health effects, including high BMI. At present, there are far more alcohol- and tobacco-control activities than there were previously. Chinese government has been promoting the implementation of alcohol- and tobacco-control

measures, but its role in the control of tobacco and alcohol use is in conflict with its reliance on the revenues of tobacco and alcohol by the selling of tobacco products and alcoholic drinks through the state-owned companies[42, 43, 2]. Therefore, we need to realize it clearly that the related public health issues will not be addressed in the short term without the adoption of measures in the country.

Declarations

Ethical approval and consent to participate

This study was approved by the Institutional Review Board of Southeast University Zhongda Hospital (no. 2012ZDIIKY19.0), in accordance with the Declaration of Helsinki. All subjects signed written informed consent in the study.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interest

All authors have completed the ICMJE form and declare that they have no competing interests.

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Authors' contributions

DP contributed to the data analysis, interpretation of data and wrote the paper. MS, JW, KW, PFL contributed to the study concept and implementation, and the collection of data. JDS contributed to the interpretation of data and revised the manuscript. GGM contributed to the data analysis and the collection of data. SKW and GJS initiated and designed this investigation, and revised the manscript. GJS is the guarantor. The corresponding author attests that all listed authors meet authorship criteria and that no others meeting these criteria have been omitted..

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Tables

Table 1 Sample characteristics of body size parameters by smoking and sex categories in study subjects. (data are mean (standard deviation))

Body size parameter	Total (n=10837)	Current smoker			Non-smoker		
		Total (n=3007)	Female (n=948)	Male (n=2059)	Total (n=7830)	Female (n=5766)	Male (n=2064)
Body mass index	24.10 (3.21)	23.83 (3.10)	24.04 (3.42)	23.74 (2.94)	24.21 (3.24)	24.19 (3.32)	24.27 (3.00)[b]
Height (cm)	161.34 (7.54)	163.57 (7.54)	157.12 (6.55)	166.53 (5.95)	160.48 (7.36)	158.27 (6.38)[a]	166.69 (6.32)
Weight (kg)	62.76 (9.17)	63.82 (9.50)	59.35 (9.25)	65.87 (8.89)	62.34 (9.01)	60.5 (8.25)[a]	67.53 (9.05)[b]

[a]Compared with female smokers, p□0.05 (Student's t test).

[b]Compared with male smokers, p□0.05 (Student's t test).

Table 2 Sample characteristics of smoking parameters by BMI and sex categories in study subjects. (data are mean (standard deviation))

Smoking behaviour parameters	Total (n=3007)	BMI category				Gender	
		Underweight (□18.5, n=59)	Normal (18.5-23.9, n=1634)	Overweight (24.0-27.9, n=1023)	Obese (≥28.0, n=291)	Female (n=948)	Male (n=2059)
Age started smoking (years)	33.37 (11.78)	30.84 (9.93)	34.97 (12.07)[a]	31.41 (11.00)[b]	31.72 (11.81)[b]	35.20 (11.26)	32.52 (11.92)
Number of cigarettes smoked per day	15.77 (9.31)	17.32 (8.52)	15.00 (8.93)	16.90 (9.84)[b]	15.89 (9.27)	13.82 (8.42)	16.67 (9.56)
Duration of smoking (years)	24.35 (12.26)	28.95 (11.77)	23.00 (12.46)[a]	25.88 (11.93)[b]	25.68 (11.47)[b]	23.58 (11.74)	24.71 (12.48)
Cumulative amount of smoking (pack-years)	21.43 (18.71)	26.67 (17.68)	19.64 (18.28)[a]	23.81 (19.33)[b]	22.09 (17.98)[b]	17.95 (16.06)	23.03 (19.60)

[a]Compared with underweight group, p□0.05 (Tamhane's T2 post-hoc test).a

[b]Compared with normal group, p□0.05 (Tamhane's T2 post-hoc test).

Table 3 ORs (and 95% CIs) of being overweight or obese according to alcohol-related variables

Drinking behaviour parameters	Overweight or obese, n=5182 (%)	Underweight or normal, n=5655 (%)	Crude OR (95%CI)	*p* value	Adjusted OR (95% CI)[1]	*p* value
Alcohol units consumed per day						
Non-drinker	4109 (79.3%)	4801 (84.9%)	1.00 (referent)	-	1.00 (referent)	-
4	207 (4.0%)	170 (3.0%)	1.42 (1.16-1.75)	0.001	1.56 (1.25-1.93)	0.001
4-	545 (10.5%)	438 (7.7%)	1.45 (1.27-1.66)	0.001	1.69 (1.46-1.96)	0.001
8-	321 (6.2%)	246 (4.4%)	1.53 (1.29-1.81)	0.001	1.76 (1.45-2.13)	0.001
p value for trend			0.001		0.001	
Duration of drinking (years)						
Non-drinker	4109 (79.3%)	4801 (84.9%)	1.00 (referent)	-	1.00 (referent)	-
20	327 (6.3%)	311 (5.5%)	1.23 (1.05-1.44)	0.012	1.36 (1.14-1.61)	0.001
20-	536 (10.3%)	386 (6.8%)	1.62 (1.41-1.86)	0.001	1.86 (1.60-2.17)	0.001
35-	210 (4.1%)	157 (2.8%)	1.56 (1.27-1.93)	0.001	1.97 (1.57-2.48)	0.001
p value for trend			0.001		0.001	
Age at starting drinking (years)						
Non-drinker	4109 (79.3%)	4801 (84.9%)	1.00 (referent)	-	1.00 (referent)	-
25-	766 (14.8%)	669 (11.8%)	1.34 (1.20-1.50)	0.001	1.54 (1.36-1.75)	0.001
20-	184 (3.5%)	127 (2.3%)	1.69 (1.35-2.13)	0.001	1.93 (1.51-2.46)	0.001
20	123 (2.4%)	58 (1.0%)	2.48 (1.81-3.40)	0.001	2.81 (2.02-3.90)	0.001
p value for trend			0.001		0.001	
Cumulative amount of drinking (unit-years)						
Non-drinker	4109 (79.3%)	4801 (84.9%)	1.00 (referent)	-	1.00 (referent)	-
40	177 (3.4%)	155 (2.7%)	1.33 (1.07-1.66)	0.010	1.43 (1.14-1.80)	0.002
40-	163 (3.1%)	144 (2.5%)	1.32 (1.05-1.66)	0.016	1.52 (1.19-1.93)	0.001
80-	159 (3.1%)	133 (2.4%)	1.40 (1.11-1.77)	0.005	1.59 (1.24-2.04)	0.001
120-	574 (11.1%)	422 (7.5%)	1.59 (1.39-1.81)	0.001	1.89 (1.62-2.20)	0.001
p value for trend			0.001		0.001	

Liquor	1042 (20.1%)	820 (14.5%)	1.48 (1.34-1.64)	0.001	1.70 (1.51-1.92)	0.001
Beer	162 (3.1%)	120 (12.4%)	1.49 (1.17-1.89)	0.001	1.48 (1.15-1.89)	0.002
Wine	19 (0.4%)	14 (0.2%)	1.48 (0.74-2.96)	0.264	1.54 (0.76-3.12)	0.231

[1]Adjusted for gender, age, education level, annual income, number of cigarettes per day and consumptions of total vegetables, fresh fruits and meats.

Table 4 ORs (and 95% CIs) of becoming a drinker according to smoking-related variables

Smoking behaviour parameters	Drinker, n=1927 (%)	Non-drinker, n=8910 (%)	Crude OR (95% CI)	*p* value	Adjusted OR (95% CI)[1]	*p* value
Number of cigarettes smoked per day						
Non-smoker	775 (40.2%)	7055 (79.2%)	1.00 (referent)	-	1.00 (referent)	-
10	156 (8.1%)	445 (5.0%)	3.19 (2.62-3.89)	0.001	2.31 (1.85-2.88)	0.001
10-	299 (15.5%)	724 (8.1%)	3.76 (3.22-4.39)	0.001	2.04 (1.72-2.43)	0.001
20-	697 (36.2%)	686 (7.7%)	9.25 (8.13-10.52)	0.001	4.88 (4.20-5.66)	0.001
p value for trend			0.001		0.001	
Duration of smoking (years)						
Non-smoker	775 (40.2%)	7055 (79.2%)	1.00 (referent)	-	1.00 (referent)	-
20	222 (11.5%)	774 (8.7%)	2.61 (2.21-3.08)	0.001	1.47 (1.22-1.77)	0.001
20-	558 (29.0%)	701 (7.9%)	7.25 (6.34-8.28)	0.001	4.30 (3.69-5.02)	0.001
35-	372 (19.3%)	380 (4.2%)	8.91 (7.59-10.47)	0.001	4.89 (4.04-5.92)	0.001
p value for trend			0.001		0.001	
Age at starting smoking (years)						
Non-smoker	775 (40.2%)	7055 (79.2%)	1.00 (referent)	-	1.00 (referent)	-
25-	713 (37.0%)	1481 (16.6%)	4.38 (3.90-4.92)	0.001	2.66 (2.33-3.04)	0.001
25	439 (22.8%)	374 (4.2%)	10.69 (9.14-12.50)	0.001	4.96 (4.16-5.92)	0.001
p value for trend			0.001		0.001	
Cumulative amount of smoking (pack-years)						
Non-smoker	775 (40.2%)	7055 (79.2%)	1.00 (referent)	-	1.00 (referent)	-
15	308 (16.0%)	967 (10.8%)	2.90 (2.50-3.36)	0.001	1.74 (1.48-2.06)	0.001
15-	342 (17.7%)	435 (4.9%)	7.16 (6.10-8.40)	0.001	4.27 (3.55-5.13)	0.001
30-	502 (26.1%)	453 (5.1%)	10.09 (8.71-11.69)	0.001	5.17 (4.36-6.14)	0.001
p value for trend			0.001		0.001	

[1]Adjusted for gender, age, BMI, education level, annual income and consumptions of total vegetables, fresh fruits and meats.

Figures

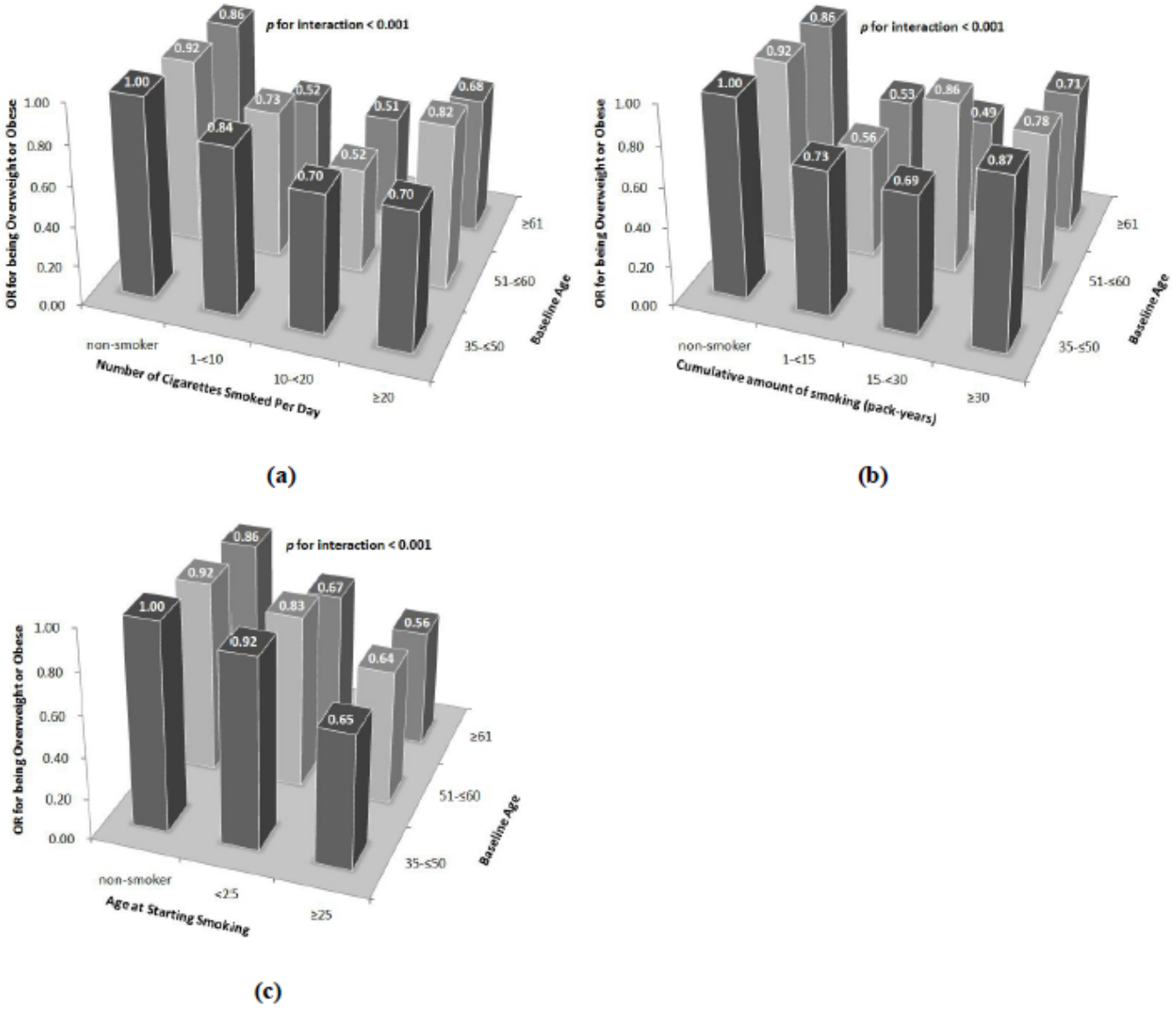

Figure 1

Odds ratios of becoming overweight or obese according to (a) number of cigarettes smoked per day, (b) cumulative amount of smoking, and (c) age at starting smoking, with model adjusted for gender, age, education level, annual income, alcohol units consumed per day, and consumptions of total vegetables, fresh fruits and meats.

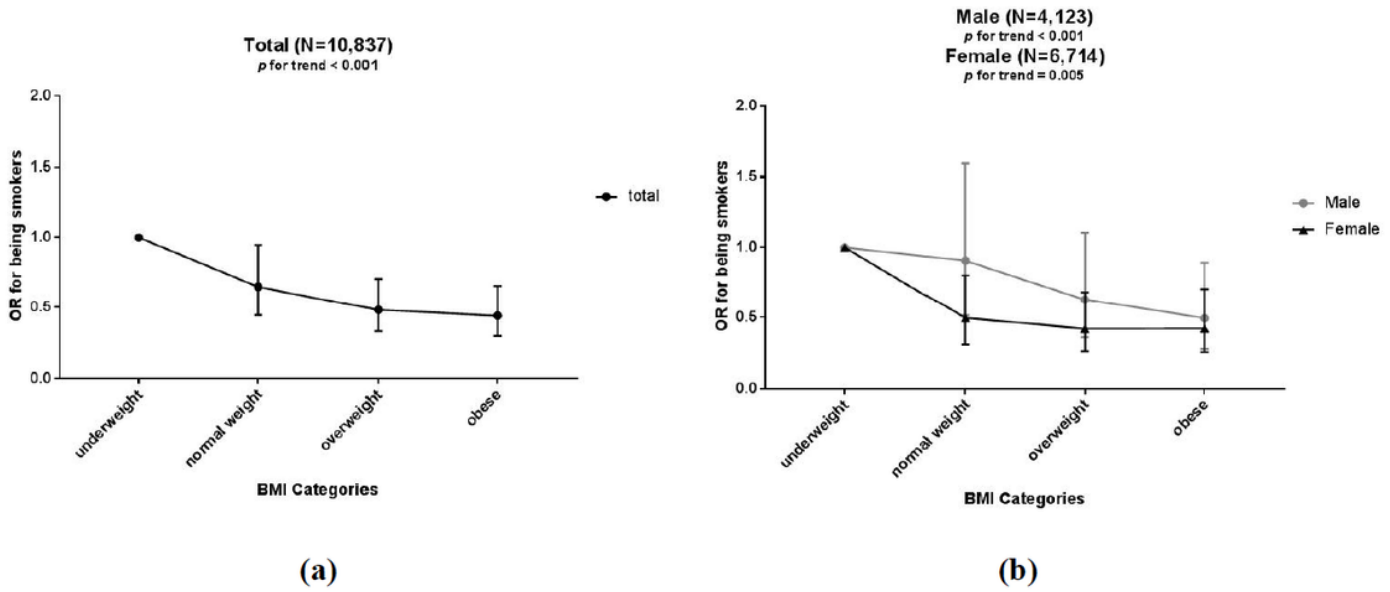

Figure 2

Odds ratios (and 95% CIs) of being current smokers according to BMI categories in (a) total subjects, and (b) males or females, with model adjusted for gender, age, education level, annual income, alcohol units consumed per day, and consumptions of total vegetables, fresh fruits and meats.

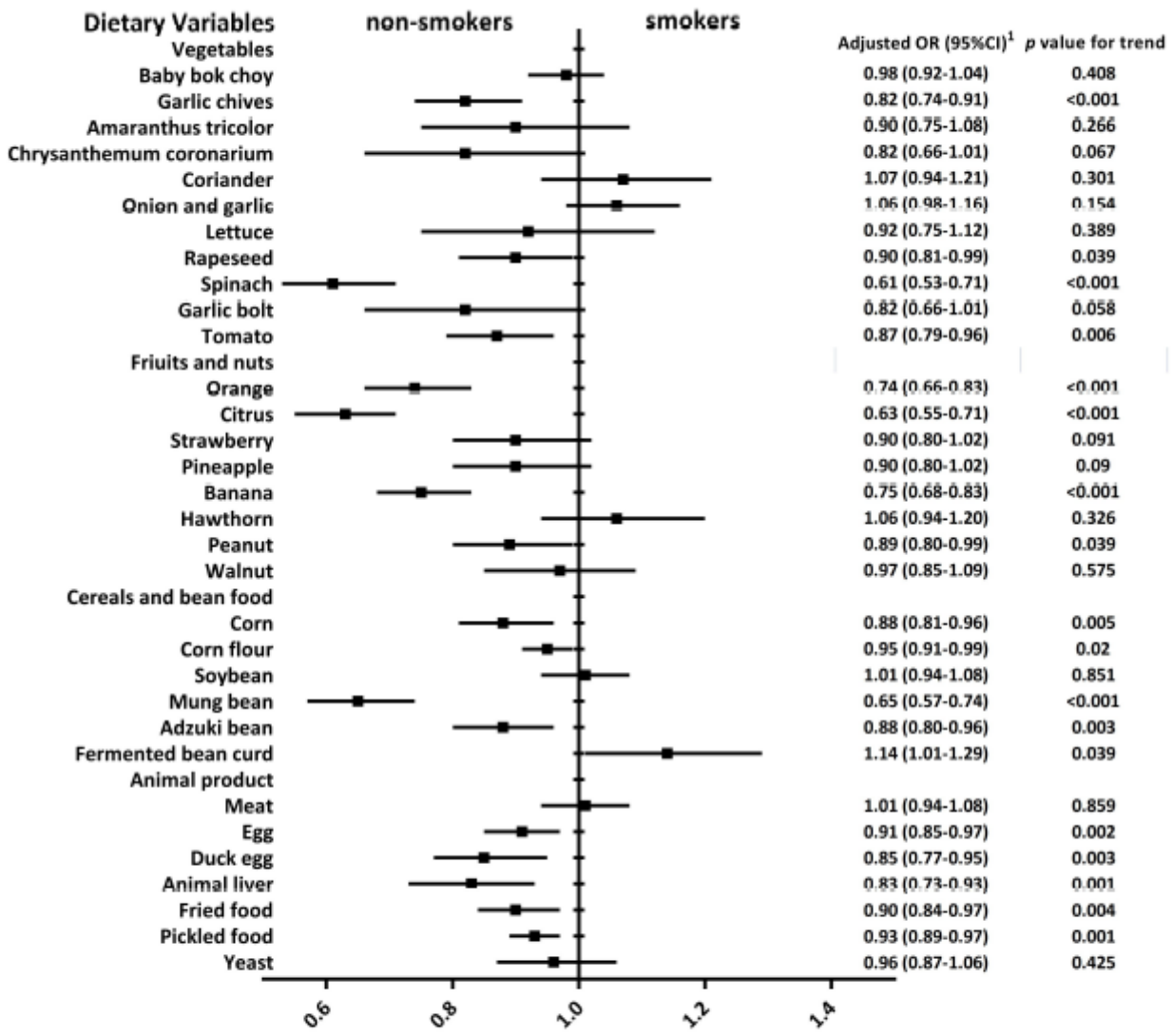

Figure 3

Differences in dietary intake frequency between current smokers and non-smokers.

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