RESEARCH COMMUNICATION

Hot Beverage and Food Intake and Esophageal Cancer in Southern China

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Abstract

Aim: Hot beverage and food intake may be associated with increased risks of esophageal cancer. In this study, we analyzed data from two hospital based case-control studies to examine this question. Methods: A structured questionnaire was used to collect data on potential risk factors of esophageal cancer from 213 cases and 213 controls in southern of China from Jan. 2007 to Dec. 2010. We calculated odds ratios (ORs) and 95% confidence intervals (CIs) using conditional multivariable adjusted logistic regression, adjusting for confounders. Results: Those who consumed hot and very hot beverages demonstrated significantly increased risk of esophageal cancer (OR=4.13, 95% CI: 2.13-8.05; OR=8.55, 95% CI: 3.67-20.9, respectively), related to increasing temperature. A high frequency of barbecued and fried food was also revealed to elevate risk of esophageal cancer (OR=3.44, 95% CI: 1.12-8.34, p for trend 0.034; OR=2.39, 95% CI: 1.25-6.32, p for trend 0.035, respectively). Furthermore, we found evidence for an association with a fast eating habit in our Chinese (OR=4.76, 95% CI: 2.12-7.74). Conclusion: This study found hot beverage and high-temperature cooking methods might greatly increase the risk of esophageal cancer. Further studies in Chinese populations with larger sample size are warranted.

Keywords: Hot beverage - high temperature cooking methods - esophageal cancer - China

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Introduction

Esophageal cancer is the sixth most common cancer worldwide, which is characterized by rapid development and poor prognosis (McCabe and Dlamini, 2005; Parkin et al., 2005). Despite development of newer diagnostic strategies and multiple therapeutics modalities, its early detection and diagnosis is still a challenge. High incidence of the cancer in certain geographic regions suggests the role of environmental risk factors in pathogenesis of esophageal cancer (Hu et al., 1994; Castellsague et al., 1999).

Hot beverages and food intake is considered to be related to esophageal cancer. The hot drinks and food must go through the esophagus into stomach, and the hot temperature would cause chronic theramal injury to the upper digestive tract, and the long-term injury might increase the risk of chronic irritation and susceptible to carcinogenesis (Mirvish, 1995). However, it has been argued that the hot beverages and food may fall rapidly in the mouth and oropharynx so that it cannot cause thermal intraesophageal temperature after their consumption (De et al., 1972). Hot beverages reported from Asian and South American countries where those beverages are often consumed at practically boiling temperature (Cheng and Day, 1996), but its relationship with esophageal cancer are conflicting (Kinjo et al., 1998; 2000; Terry et al., 2001; Wu et al., 2009; Ibiebele et al., 2010). Kinjo and colleagues (Kinjo et al., 1998) reported that drinking hot tea was significantly associated with an increased risk for esophageal cancer among both Japanese men (RR = 1.5, 95% CI: 1.1-2) and women (RR = 1.8, 95% CI: 1.1-2.9) after 15 years of follow-up and after adjustment for age, socioeconomic status and smoking.

A population-based study of both genders in Sweden, analyzed risk of adenocarcinoma of the oesophagus and squamous cell cancer as separate outcomes (Terry, 2000) and reported no association between hot beverage intake and either type of esophageal cancer after adjusting for a number of confounders including smoking and alcohol consumption. Another large sample population-based case-control study conducted in China revolved the hot tea temperatures significantly increased esophageal cancer risk, but it did not adjust other hot food intake (Wu et al., 2009).

Therefore, we conducted two population-based case-control studies in Sichuan and Guandong Provinces of China. In this analysis, we evaluate the association of EC with hot beverage and food after adjusting potential risk factors. The results may help us improve the current

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understanding of effects of hot beverage and food on the development of EC.

Materials and Methods

Study subjects

A population-based case-control study has been conducted from Jan. 2007 to Dec. 2010 in the General Hospital of Chengdu Military Area of Chengdu, Sichuan province and in the First Affiliated Hospital of Shantou University Medical College, Guangdong province. The 223 subjects were restricted to local inhabitants who have lived in Sichuan and Guangdong provinces for at least 5 years. Newly diagnosed primary ES patients from local adult residents were recruited as cases. All patients recruited in this study were examined endoscopically and histologically confirmed. Among 223 cases eligible cases, 213 were interviewed with a participation rate of 95.5%. Of 213 cases, there were 175 squamous cell esophageal cancer and 38 esophageal adenocarcinoma. Controls were selected from health individuals visiting Hospital for routine physical examination in the same hospital during the same period. Controls were required to be without any history of any malignancy, digestive diseases, chronic diseases and also no prior history of malignancy. Controls and cases were frequency matched by gender and age (±3 years). By study design, a total of 213 cases and 213 controls were collected in our study.

The ethics committees of the General Hospital of Chengdu Military Area and First Affiliated Hospital of Shantou University Medical College reviewed and approved the study, and informed consent was obtained from all participants.

Data collection

Using a structured questionnaire, with written informed consent, we collected sociodemographic characteristics and potential confounding factors by face to face interviews. The trained interviewers were not aware of the study hypothesis.

Dietary data were obtained by using a 94-item food frequency questionnaire (FFQ). Controls were asked to report how often they consumed a specified amount of food item on the FFQ in the previous year. Cases were asked to report their usual frequency of consumption in the year before diagnosis, their usual diet. In addition to the main FFQ items, all participants completed additional questions about the usual temperature at which tea or coffee or (other hot beverages was at which tea or other hot beverages) was consumed, and there were luke-warm, warm, hot and very hot. For analysis regarding the number of cups of hot beverages consumed, all type of beverages were combined to form the total amount of all hot drinks (plain water, soup and green tea) consumed. We also investigated the frequency of consumption of fried food (prepared at home or take-away), spicy foods, and barbecued meats.

We collected data about other factors using a structure questionnaire. Information was collected on demography (age, sex), social background (education), as well as height and weight 1 year ago (1 year before diagnosis for cases). We calculated body mass index (BMI) by dividing weight in kilograms by the square of height in meters. BMI categories used for analysis were low (<18.5 kg/m2), normal (18.5-23.9 kg/m2), overweight (24-27.9 kg/m2) and obesity (>=28 kg/m2). Alcohol drinking was categorized into never and moderate and heavy drinkers. Individuals who drank 100 -250 g alcohol (400 ml beers, 250 wine ml and 100 ml white spirit) per month and continued for 6 months were regarded as moderate drinkers. Those who drank more than 250 g alcohol per month were as heavy drinkers, and less than 100 g alcohol were as rare drinkers. Tobacco smoking was categorized into never and current drinking. Individuals who smoked 20-50 packets of cigarettes per year, or smoked more than one cigarette per day and continued for 6 months were regarded as moderate smokers. Those who smoked more than 50 packets of cigarettes per years were as heavy drinkers, and less than 20 packets of cigarettes were as rare drinkers.

Statistical analysis

The distributions of demographic characteristics and potential risk factors were compared among cases and controls using chi-square test for proportions. We estimated the risk of esophageal cancer associated with categories of exposure variables by calculating the odds ratios (ORs) and 95% confidence intervals (Cls) for each of the case groups using unconditional multivariable

Table 1. Characteristics of Study Subjects

Characteristic	Cases (%) n=213	Controls (%) n=213	P value
Age years(mean±SD)	54.5±4.9	52.5±3.7	-
Sex			
Men	147(69)	147(69)	-
Women	66(31)	66(31)	
Education level			
Illiteracy	26(12)	17(8)	0.148
Body mass index (kg/m2)			
<18.5	48(22)	34(16)	0.091
18.5-23.9	102(48)	96(45)	
24-27.9	42(20)	48(23)	
>=28	21(10)	35(16)	
Cancer Family history (First degree relatives)			
Yes	44(21)	25(10)	0.012
Smoking status (g alcohol/ per month)			
Never	83(39)	121(57)	<0.001
<100	58(27)	55(26)	
100-250	34(16)	13(6)	
>250	38(18)	23(11)	
Alcohol drinking status (packets of cigarettes / year)			
Never	43(20)	77(36)	<0.001
<20	66(31)	72 (34)	
20-50	47(22)	36(17)	
>50	58(27)	28(13)	
Vegetable (times / week)			
<3	85(40)	49(23)	0.005
4-6	79(37)	79(37)	
>6	49(23)	64(30)	
Fruit (times / week)			
<3	113(53)	77(36)	0.002
4-6	58(27)	70(33)	
>6	43(20)	66(31)	

Table 2. Odds Ratios (95% Cls) of Esophageal Cancer Risk with Hot Beverage Behaviors

Variables	All type of esophageal cancer			Squamous cell esophageal cancer	
	Cases (%)*	Controls (%)*	Adjusted odds ratio (95% CI)[1]	Cases (%)**	Adjusted odds ratio (95% CI)[1]
Temperature of beverage					
Luke-warm	23(11)	59(21)	1.0(reference)	17(10)	1.0(reference)
Warm	58(27)	102(48)	1.17(0.62-2.87)	44(25)	1.53(0.82-3.24)
Hot	92(43)	53(25)	4.13(2.13-8.05)	84(48)	5.61(2.91-11.8)
Very hot	40(19)	12(6)	8.55(3.67-20.9)	30(17)	9.12(4.03-24.7)
p for trend			<0.001		<0.001
Amount of hot beverage consumed per day (cups / day)					
<3	21(23)	13(25)	1.0(reference)	18(21)	1.0(reference)
4-6	29(31)	18(33)	1.03(0.42-3.13)	30(36)	1.34(0.56-3.41)
>6	42(46)	22(42)	1.43(0.51-3.41)	36(43)	1.21(0.45-3.20)
p for trend			0.67		0.78
Amount of very hot beverage consumed per day (cups / day)					
<3	5(12)	2(20)	1.0(reference)	4(14)	1.0(reference)
4-6	18(45)	6(49)	1.34(0.13-11.7)	14(47)	1.19(0.09-12.4)
>6	17(43)	4(31)	1.82(0.29-17.3)	12(39)	1.63(0.12-17.5)
p for trend			0.32		0.54
Frequency of consumption of barbecued meat (times /week)					
<2	160(75)	188(88)	1.0(reference)	117(67)	1.0(reference)
2-3	43(20)	19(9)	1.93(0.88-5.95)	40(23)	2.07(0.97-4.89)
>3	11(5)	6(3)	3.44(1.12-8.34)	18(10)	3.13(1.34-8.21)
p for trend			0.034		0.0047
Frequency of fried food (times/week)					
<2	66(31)	119(56)	1.0(reference)	49(28)	1.0(reference)
2-3	98(46)	66(31)	1.46(0.72-4.99)	86(49)	1.77(0.85-5.48)
>3	49(23)	28(13)	2.39(1.25-6.32)	40(23)	2.46 (1.39-7.11)
p for trend			0.035		0.13
Speed of eating					
Slow	37(17)	70(33)	1.0(reference)	21(12)	1.0(reference)
Moderate	113(53)	109(51)	1.48(0.78-2.95)	100(57)	2.97(1.60-5.91)
Quick	64(30)	34(16)	4.76(2.12-7.74)	54(31)	5.54(2.72-11.9)
p for trend			0.0042		0.0011

*n=213; **n=17; [1]Adjusted for age, sex, educational status, smoking, drinking, body mass index, vegetable and fruit

logistic regression. The multivariable logistic regression model adjusted for the confounding effects of age, sex, educational status, smoking, drinking, body mass index, vegetable and fruit. We performed the trend analysis for beverage drinking temperature variables. To assess the association between temperature of hot beverage and esophageal cancer, we adjusted further for green tea intake. We re-analyzed the data after restricting cases to cases with squamous cell carcinoma to see whether the risk estimates differs by histological type. p-values were two sided, and p<0.05 was considered statistically significant.

Results

Characteristics of cases and controls were presented in Table 1. Esophageal cancer cases were more likely to be lower BMI, heavy tobacco and heavy alcohol consumers. Individuals with cancer family history were more susceptibility to esophageal cancer.

Table 2 details the risk estimates for the associations between hot beverage habits and risk of esophageal cancer. We found evidence that those who drank hot or very hot beverage had high or strong risks of esophageal cancer than those who consumed luke-warm beverage (OR=4.13, 95% CI: 2.13-8.05; OR=8.55, 95% CI: 3.67-20.94, respectively). The linear trend analysis suggested a significant increase in risk with increasing temperatures of beverage consumption for esophageal cancer (p <0.001). The amount of hot or very hot beverage consumed per day was not associated with risk of esophageal cancers. There were significant association between the high-temperature cooking methods and risk of esophageal cancer. The high frequency of consuming barbecued food more than 3 times a week was associated with an increased risk of esophageal cancer compared to less than two times a week (OR=3.44, 95% CI: 1.12-8.34, p for trend 0.034). Also, we found a positive association between high frequency of consuming fried food more than 3 times a week and esophageal cancer with high risk estimates (OR=2.39, 95% CI: 1.25-6.32, p for trend 0.035). Furthermore, we found evidence that fast eating habit was association with increased risk of esophageal cancer (OR=4.76, 95% CI: 2.12-7.74). Results of sensitivity analysis restricted to the dominant histological type, squamous cell carcinoma, revealed no strong difference from the pooled results of all histological types.

Discussion

This present study was the first one that has been performed in a Chinese population to investigate the effect of hot beverage on esophageal cancer risk. The study suggested that hot beverage intake might increase the risk of esophageal cancer. Such findings were in line with those

of a previous study conducted in China that the OR was 3.1 for those who drank high temperature tea(Wu et al., 2009). We found a significant association of esophageal cancer risk with barbecued meat and fried food. However, a previous population-based study in Australia showed that the fired foods, barbecued meat and fast eating habits were not associated with esophageal cancer risk (Ibiebele et al., 2010). The inconsistency of these studies may be explained by differences in population background, study design, sample size, and also by chance. Further confirmation of existing findings is still needed in future studies.

In previous epidemiological studies, high-temperature cooking methods including barbecuing and frying have been associated with carcinogenic substances such as heterocyclic amines (HCA) and polycyclic aromatic hydrocarbons (PCAH) (Terry et al., 2003). Early hospital-based case-control studies from Uruguay AND Argentina found a twofold increased esophageal cancer risk (De Stefani et al., 1990; Castelleto et al., 1994), and our study suggested a higher risk of esophageal cancer for those who frequently ate compared to never/rare consumed barbecued meat. But a recent study conducted in United States found a non-significant elevated EAC risk. This inconsistence might be the different etiology of histological type. Our study perform sensitivity analysis on the histological types of esophageal cancer, squamous cell carcinoma and adenocarcinoma, but the sensitivity analysis restricted to the dominant histological type, revealed no strong difference, and the statistical power was even lower.

Previous study suggested hot food could cause chronic theramal injury to the upper digestive tract, and increase the susceptibility of developing esophageal cancer. The thermal injury may cause esophageal cancer via both direct and indirect pathways. Inflammatory processes associated with chronic irritation of the esophageal mucosa by local hyperthermia might simulate the endogenous formation of reactive nitrogen species, and subsequently, nitrosamines (Mirvish, 1995), thus to induce carcinogens. Thermal injury can impair the barrier function of the esophageal epithelium, which may increase the risk of damage from exposure to intraluminal carcinogens (Tobey et al., 1999). Our study suggest a strong esophageal cancer risk when drank very hot beverage.

Our study has strengths and limitations. Strengths of the study include the population-based design, and rapid recruitment of cases soon after diagnosis. Weakness include the retrospective and self-report nature of dietary data collection. Of particular concern is that early symptoms of esophageal cancer may have caused changes in eating behavior before diagnosis among the cases. However, the case-control study could not neglect the recall bias. Therefore, a prospective study is needed to verify the results of our study. The temperature of beverage were measured by self-report, and it is hard to verify whether there is difference between the real and reported temperatures.

In conclusion, this study found evidence that hot beverage might greatly increase the risk of esophageal cancer. High-temperature cooking methods including barbecuing and frying were observed significant association with esophageal cancer risk. Further studies in Chinese populations with larger sample size are still warranted.

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