

## RESEARCH ARTICLE

# High Temperature of Food and Beverage Intake Increases the Risk of Oesophageal Cancer in Xinjiang, China

Li Tang<sup>1</sup>, Fenglian Xu<sup>2</sup>, Taotao Zhang<sup>3</sup>, Jun Lei<sup>4</sup>, Colin William Binns<sup>1</sup>, Andy Ho-Won Lee<sup>1\*</sup>

## Abstract

**Background:** The north-western region of China has a high incidence of oesophageal cancer. This study aimed to investigate whether the intake of food and beverage at high temperature is associated with the risk of oesophageal cancer among adults residing in this remote part of China. **Materials and Methods:** A case-control study was undertaken in Urumqi and Shihezi, Xinjiang Uyghur Autonomous Region of China, between 2008 and 2009. Participants were 359 incident oesophageal cancer patients and 380 hospital-based controls. Information on temperature of food and beverage intake was obtained by face-to-face interview. Logistic regression analyses were performed to ascertain the association between intake temperature and the risk of oesophageal cancer. **Results:** The oesophageal cancer patients consumed foods and beverages at higher temperatures than controls,  $p < 0.001$ . High temperature of tea, water and food intake appeared to increase the risk of oesophageal cancer by more than two-fold, with adjusted odds ratio (95% confidence intervals) of 2.86 (1.73-4.72), 2.82 (1.78-4.47) and 2.26 (1.49-3.45), respectively. **Conclusions:** Intake of food and beverage at high temperature was positively associated with the incidence of oesophageal cancer in north-western China.

**Keywords:** Case-control study - intake temperature - oesophageal cancer - China

*Asian Pac J Cancer Prev*, 14 (9), 5085-5088

## Introduction

Oesophageal cancer is the eighth most common malignancy and the sixth leading cause of cancer-related deaths worldwide. In 2008, more than 480,000 new cases were diagnosed and approximately 407,000 people died from oesophageal cancer. The incidence of oesophageal cancer varied between regions. For instance, the age-standardised rate in Eastern Asia (14.2 per 100,000) was four times or more higher than the rate in North America (3.2 per 100,000) (Ferlay et al., 2010).

China carries a big burden of oesophageal cancer with an incidence of 19.3 per 100,000 in 2008 (Ferlay et al., 2010), and accounts for more than half the new cases diagnosed in the world (Zhao et al., 2012). Xinjiang Uyghur Autonomous Region, located in the northwest of China, is one of the areas constituting the so-called 'Asian Oesophageal Cancer Belt' (Zheng et al., 2010). According to a survey undertaken in Yili, Xinjiang, between 2005 and 2008, the incidence of oesophageal cancer was 30.2 per 100,000, much higher than the national average during the same period (Ainiwaer et al., 2011).

The positive association between high-temperature foods and beverages and risk of oesophageal cancer has been reported in several countries (Castellsague et al., 2000; Islami et al., 2009), including China (Lin et al.,

2011). A recent case-control study conducted in Jiangsu Province found a significantly elevated risk of oesophageal cancer due to drinking tea at high temperatures (Wu et al., 2009). Similar to other provinces in China, foods and beverages are usually consumed at high temperature by Xinjiang residents. However, there has been no report with respect to the development of oesophageal cancer in this remote part of China. The present study aimed to investigate whether the intake of food and beverage at high temperature is associated with the risk of oesophageal cancer among Xinjiang adults.

## Materials and Methods

### Study design and participants

A hospital-based case-control study of oesophageal cancer was conducted in Urumqi and Shihezi, Xinjiang Uyghur Autonomous Region of China, between January 2008 and December 2009. Subjects were recruited from four hospitals, namely, Xinjiang Tumour Hospital, Shihezi People's Hospital, Kuitong Hospital and No. 1 Affiliated Hospital of Shihezi University.

Medical records and pathology reports were reviewed to identify newly diagnosed patients (within the past 12 months). Pathological diagnoses were based on the World Health Organization Classification of Tumours of the

<sup>1</sup>School of Public Health, Curtin University, Perth, Australia, <sup>2</sup>School of Women's and Children's Health, University of New South Wales, Sydney, Australia, <sup>3</sup>School of Medicine, Shihezi University, Shihezi, <sup>4</sup>Xinjiang Tumour Hospital, Urumqi, China \*For correspondence: [Andy.Lee@curtin.edu.au](mailto:Andy.Lee@curtin.edu.au)

Digestive System (Garbber et al., 2000). Patients without histopathologically confirmed oesophageal cancer and those who reported memory problems affecting their recall of past events were excluded. Of the total 364 patients identified, 359 consented to participate in the study.

Controls were recruited from inpatient wards at the same hospitals from the Departments of Ophthalmology, Orthopedic, Respiratory Disease and Physiotherapy. Exclusion criteria for controls were previous diagnosis of malignant disease, on long-term medical diet, and self-reported memory problems. Whenever more controls were available than could be interviewed, the final selection was made using random numbers. Of the 400 eligible controls recruited to frequency matched with cases by gender and age ( $\pm 5$  years), 380 eventually gave their consent to be interviewed. There were no significant differences in age, gender and demographics between participants and non-participants.

The study protocol was approved by the participating hospitals and the Human Research Ethics Committee of Curtin University (approval number HR 56/2006). Written informed consent was obtained from all participants, who were assured of confidentiality of the information provided and their right to withdraw at any time without prejudice.

#### Data collection

All participants were interviewed by trained interviewers, usually in the presence of their next-of-kin to help the recall of past events. The structured questionnaire used composed of questions on demographic characteristics, anthropometry, past and family medical history, diet, and lifestyle such as cigarette smoking and alcohol consumption. Information on dietary habits was solicited, including whether participants drank tea and water and ate foods at low, mild or high temperatures. The reference recall period for diet and lifestyle variables was set at five years before diagnosis for cases and five years before interview for controls. On average each interview took about 30 minutes to complete.

#### Statistical analysis

Descriptive statistics were used to summarise the sample characteristics. Unconditional logistic regression analysis was performed to assess the effect of intake temperature on the oesophageal cancer risk. Both crude and adjusted odds ratios (OR) and corresponding 95% confidence intervals (CI) were computed. For each

exposure variable (tea, water and food), its intake temperature was categorised as low or mild and high. Other variables included in the logistic regression models were age (years), gender, education level (none/primary, secondary, tertiary), body mass index (5 years ago, kg/m<sup>2</sup>), smoking status (never, ever), alcohol drinking (never/seldom, often), family history of cancer in first-degree relatives (no, yes) and daily intakes of vegetables and fruits (g). These variables were considered plausible confounding factors of oesophageal cancer risk in the literature.

## Results

Table 1 summarises characteristics of the sample by case-control status. The participants were on average 61 (SD 11.4) years old with mean body mass index 24.1 (SD 3.7) kg/m<sup>2</sup>. Approximately 72% of them were male. About half the participants were smokers and regularly drank alcoholic beverages. Compared to the controls, patients with oesophageal cancer tended to belong to the ethnic minority group, have lower education level but a family history of oesophageal cancer, and consume less fruit and vegetables in daily life.

Table 2 shows the results of logistic regression

**Table 1. Characteristics of Participants by Case-control Status**

Variable		Cases n (%)	Controls n (%)	p*
Gender	Male	260 (72.4)	269 (70.8)	0.623
	Female	99 (27.6)	111 (29.2)	
Ethnic group	Han	270 (75.2)	322 (84.7)	0.001
	Minority	89 (24.8)	58 (15.3)	
Education level	None/primary	183 (51.0)	136 (35.8)	<0.001
	Secondary	140 (39.0)	191 (50.3)	
	Tertiary	36 (10.0)	53 (13.9)	
Smoking status	Never	164 (45.7)	192 (50.5)	0.188
	Ever	195 (54.3)	188 (49.5)	
Alcohol drinking	Never/seldom	193 (53.8)	187 (49.2)	0.216
	Often	166 (46.2)	193 (50.8)	
Family history of cancer in first-degree relatives	No	306 (85.2)	356 (93.7)	<0.001
	Yes	53 (14.8)	24 (6.3)	
		mean (SD)	mean (SD)	
Age at interview (years):		61.4 (11.0)	60.6 (11.8)	0.338
Body mass index (5 years ago, kg/m <sup>2</sup> ):		24.3 (3.8)	24.0 (3.6)	0.181
		mean (SD)	mean (SD)	
Daily intake of vegetables (g):		677.8 (542.6)	874.3 (621.8)	<0.001
Daily intake of fruit (g):		342.0 (410.6)	463.1 (480.6)	<0.001

\*Chi-square or t-test for difference between cases and controls

**Table 2. Crude and Adjusted Odds Ratio (95% confidence interval) of Oesophageal Cancer Risk in Relation to Temperature of Food and Beverage Intake in Xinjiang, China**

Variable		Cases n (%)	Controls n (%)	Crude OR (95% CI)	Adjusted OR* (95% CI)	p*
Temperature of tea	Low or mild	294 (81.9)	352 (92.6)	1	1	<0.001
	High	65 (18.1)	28 (7.4)	2.78 (1.74, 4.44)	2.86 (1.73, 4.72)	
Temperature of water	Low or mild	283 (78.8)	347 (91.3)	1	1	<0.001
	High	76 (21.2)	33 (8.7)	2.82 (1.82, 4.38)	2.82 (1.78, 4.47)	
Temperature of food	Low or mild	276 (76.9)	337 (88.7)	1	1	<0.001
	High	83 (23.1)	43 (11.3)	2.36 (1.58, 3.52)	2.26 (1.49, 3.45)	

\*From separate logistic regression models adjusting for age (years), gender, education level (none/primary, secondary, tertiary), body mass index (5 years ago, kg/m<sup>2</sup>), smoking status (never, ever), alcohol drinking (never/seldom, often), family history of cancer in first-degree relatives (no, yes), daily intake of vegetables (g) and daily intake of fruit (g)

analyses for temperature of tea, water and food intake. The oesophageal cancer patients consumed foods and beverages at higher temperatures than controls,  $p < 0.001$ . High temperature of tea, water and food intake appeared to increase the risk of oesophageal cancer by more than two-fold, with adjusted OR (95% CI) 2.86 (1.73-4.72), 2.82 (1.78-4.47) and 2.26 (1.49-3.45), respectively. Similar findings of positive associations were observed based on subgroup analysis by ethnic group (Han and minority Uyghur people), results of which were omitted for brevity.

## Discussion

The present study provided the first report on the positive association between high-temperature food and beverages and the risk of oesophageal cancer in northwest China, an area with high incidence of oesophageal cancer in the Asia Pacific region. Our findings are consistent with a previous case-control study conducted in Sichuan and Guangdong Provinces of China, which suggested that intake of hot beverages could significantly increase the risk of oesophageal cancer (Lin et al., 2011). In another case-control study from Heilongjiang Province of China, high temperature of meals and drinks was identified as a strong risk factor for oesophageal cancer (Hu et al., 1994). Similar results were also reported in Jiangsu Province (Wu et al., 2009), Shanghai (Gao et al., 1994), Hong Kong (Cheng et al., 1995) and Taiwan (Hung et al., 2004). On the other hand, no apparent association between hot liquid intake and oesophageal cancer was evident according to a prospective cohort study conducted in Linxian, Shanxi Province of China, between 1986 and 2001 (Tran et al., 2005).

There are some plausible mechanisms through which high-temperature food and beverages contribute to the development of oesophageal cancer, and involve both direct and indirect pathways. The chronic thermal irritation of oesophageal mucosa might stimulate the endogenous formation of reactive nitrogen species and subsequently form carcinogenic nitrosamines. It has also been hypothesized that the repeated thermal injury may impair the barrier function of the oesophageal epithelium, thereby making it more vulnerable to the damage by intraluminal carcinogens (Islami et al., 2009; Melhado et al., 2010).

In this study, a standardized identification procedure was implemented that ensured the ascertainment of cases was maximised and complete. To avoid misclassification of the case-control status, we recruited only incident patients who had been diagnosed with oesophageal cancer within the past 12 months and subsequently confirmed with pathology. All controls were carefully screened. To determine the effect of high food and beverage temperature, information on other exposures and confounding factors such as tobacco smoking, alcohol drinking, and fruit and vegetables intake, was also collected. It was possible that some oesophageal cancer cases might have modified their dietary behaviours since the onset of the disease. To avoid reverse causation, the reference period for the recall of intake habits was set at five years before diagnosis for cases and five years before

interview for controls.

Several issues should be taken into consideration when interpreting the findings. Exposure misclassification was a possibility because the intake temperature of food and beverage was based on self-report which could not be verified. Nevertheless, previous studies undertaken in southern China and northern Iran have shown moderate to good agreement between reported tea drinking temperature and actual temperature measurements, with Spearman's coefficient ranged between 0.62 and 0.69 (Islami et al., 2009; Chen et al., 2011). Information bias and recall bias were unlikely since all participants remained blind to the study hypothesis, while the harmful effects of hot food and beverage intake on oesophageal cancer have not been established in the study population. Moreover, the use of four hospitals for recruitment reduced sampling bias, and as they serve the entire catchment region, the participants could be considered as representative of the target population of Xinjiang Province.

In conclusion, this study found that intake of food and beverage at high temperature was positively associated with the incidence of oesophageal cancer in northwest China. Prospective cohort studies with actual temperature measurements of foods and beverages are recommended to confirm the observed findings. In the meantime, it is advisable to avoid the intake of hot food and beverages for the prevention of oesophageal cancer in this high-risk area of China.

## Acknowledgements

The authors are indebted to the oesophageal cancer patients and control participants who agreed to be interviewed. Thanks are also due to the medical and nursing staff of the participating hospitals for their assistance in patient recruitment.

## References

- Ainiwaer J, Li D, Zhang L, et al (2011). A survey of oesophageal cancer incidence in Yili, Xinjiang between 2005 and 2008. *Xinjiang Med J*, **41**, 112-4.
- Castellsague X, Munoz N, De Stefani E, et al (2000). Influence of mate drinking, hot beverages and diet on esophageal cancer risk in South America. *Int J Cancer*, **88**, 658-64.
- Chen Z, Chen Q, Xia H, Lin J (2011). Green tea drinking habits and esophageal cancer in southern China: a case-control study. *Asian Pac J Cancer Prev*, **12**, 229-33.
- Cheng KK, Duffy SW, Day NE, Lam TH (1995). Oesophageal cancer in never-smokers and never-drinkers. *Int J Cancer*, **60**, 820-2.
- Ferlay J, Shin H, Bray F, et al (2010). Cancer incidence and mortality worldwide. International Agency for Research on Cancer, Lyon, France.
- Gao YT, McLaughlin JK, Gridley G, et al (1994). Risk factors for esophageal cancer in Shanghai, China. II. Role of diet and nutrients. *Int J Cancer*, **58**, 197-202.
- Garbbert HE, Shimoda T, Hainaut P, et al (2000). Tumours of the Oesophagus. In 'World Health Organization Classification of Tumours. Pathology and Genetics of Tumours of the Digestive System', Eds Hamilton SR and Aaltonen LA. IARC Press, Lyon.
- Hu J, Nyren O, Wolk A, et al (1994). Risk factors for oesophageal

- cancer in northeast China. *Int J Cancer*, **57**, 38-46.
- Hung HC, Huang MC, Lee JM, et al (2004). Association between diet and esophageal cancer in Taiwan. *J Gastroenterol Hepatol*, **19**, 632-7.
- Islami F, Boffetta P, Ren JS, et al (2009). High-temperature beverages and foods and esophageal cancer risk--a systematic review. *Int J Cancer*, **125**, 491-524.
- Islami F, Pourshams A, Nasrollahzadeh D, et al (2009). Tea drinking habits and oesophageal cancer in a high risk area in northern Iran: population based case-control study. *BMJ*, **338**, 929.
- Lin J, Zeng R, Cao W, et al (2011). Hot beverage and food intake and esophageal cancer in southern China. *Asian Pac J Cancer Prev*, **12**, 2189-92.
- Melhado RE, Alderson D, Tucker O (2010). The changing face of esophageal cancer. *Cancers*, **2**, 1379-404.
- Tran GD, Sun XD, Abnet CC, et al (2005). Prospective study of risk factors for esophageal and gastric cancers in the Linxian general population trial cohort in China. *Int J Cancer*, **113**, 456-63.
- Wu M, Liu AM, Kampman E, et al (2009). Green tea drinking, high tea temperature and esophageal cancer in high- and low-risk areas of Jiangsu Province, China: a population-based case-control study. *Int J Cancer*, **124**, 1907-13.
- Zhao J, He YT, Zheng RS, Zhang SW, Chen WQ (2012). Analysis of esophageal cancer time trends in China, 1989-2008. *Asian Pac J Cancer Prev*, **13**, 4613-7.
- Zheng S, Vuitton L, Sheyhidin IC, et al (2010). Northwestern China: a place to learn more on oesophageal cancer. Part one: behavioural and environmental risk factors. *Eur J Gastroenterol Hepatol*, **22**, 917-25.