RESEARCH COMMUNICATION

Comparison of Lifestyle and Living Environment Among High Risk Immigrant and Low Risk Host Residents: Implications for Esophageal Cancer Etiology

Xiang Yu[1], Tao Zhang[1], Hexi Zhang[2], Andong Hu[1], Yang Hu[1], Weiren Guo[3], Youjie Wang[1*]

Abstract

Background: It has been hypothesized that the high prevalence of esophageal squamous cell carcinoma (ESCC) in China is associated with specific environments and lifestyles. A previous study found that immigrant residents (IR) from Henan, residing long term in the town of Caihu, had significantly greater risk of dying from ESCC than host residents (HR). Objectives: This study was conducted to compare lifestyle and living environments between high risk IR and low risk HR to determine risk factors for ESCC. Methods: The subjects included randomly selected IR and HR living in Caihu. Information on lifestyle and the living environment of participants was collected by interview using a structured questionnaire. Results: The IR were found to have a higher consumption of hot food ($P<0.05$), pickled vegetables ($P<0.05$) and a lower consumption of fresh fruits and vegetables, and alcohol ($P<0.05$), compared with the HR. There were no significant differences in income and cigarette smoking between the two populations. Fewer IR families had a separate kitchen ($P<0.05$) than host families. Conclusions: Our study provided some epidemiological evidence indicating that dietary factors, such as hot food, pickled vegetables, salt, and low fruit and vegetable intake, as well as a poor living environment, are possibly related to the higher prevalence of ESCC in IR. However, cigarette smoking, alcohol drinking and income were not shown to be risk factors for immigrant susceptibility to ESCC in our study.

Keywords: Diet - esophageal cancer - immigrants - life style - living environment

Asian Pacific J Cancer Prev, **11**, 1-6

Introduction

Esophageal squamous cell carcinoma (ESCC) is the eighth most common malignancy in the world, and the fourth leading type of cancer in China, yet the etiology of this lethal disease remain to be elucidated (Li, 1982; Falk, 2009; Szumilo, 2009). Major geographic variations exist in the prevalence of ESCC within China. This geographic distribution indicates that environmental and genetic factors of specific populations may play an important role in the etiology of ESCC (Wu et al., 2006). The environmental risk factors mainly include diet, lifestyle and the living environment (Montesano and Hall, 2001; Kamangar et al., 2009). A diet lacking fresh vegetables and fruits, with vitamin and mineral deficiency was reported as a factor in areas of China at high risk of ESCC (Xibin et al., 2002). Tobacco smoking, alcohol drinking, and hot food intake were reported as significant lifestyle risk factors for ESCC (Xu, 2009). Researchers also showed that a lack of some trace elements in the natural environmental was also associated with ESCC (Li et al., 1998).

Between 1964 and 1965, 40,000 residents of Xichuan County, Henan Province, China immigrated to the town of Caihu as a result of construction of a dam across the Danjiang River. Xichuan County is located in the center of China and is in the Taihang Mountain area, which is a famous region in the world with high prevalence of ESCC, while the resettled area of Caihu has a low prevalence of ESCC in China. Our previous study showed that, even though the migrants had lived away from their original environment for over 40 years, they still had a high ESCC mortality rate compared with host residents (HR). Immigrant residents (IR) had more than nine times the rate of death from ESCC compared with HR (61.6/100,000 vs. 6.7/100,000). The new natural environment of the IR is completely different as Xichuan County is in a mountain area, whereas Caihu is in the plains (Zhang et al., 2009). Whether the IR still maintained their traditional diet or lifestyle and whether this was related to ESCC carcinogenesis is unknown. The objective of this study was to compare the differences in lifestyles, diet and the living environment between HR and IR, and to assess whether these differences could explain the high risk of ESCC among the migrants.

*[1]School of Public Health, Tongji Medical College, Huazhong University of Science and Technology, Wuhan, Hubei Province, [2]Department of Preventive Medicine, Xinxiang Medical College, Xinxiang, Henan Province, [3]Health Bureau of Zhongxiang City, Hubei Province, China *For correspondence : wangyoujie@mails.tjmu.edu.cn*

Materials and Methods

Study subjects

Caihu is located in the central part of Hubei province, China, and is the region with the largest number of immigrants who emigrated from the high risk ESCC area of Henan province during the period 1964-1965. Henan migrants and their families accounted for more than 60% of the 120,000 population of Caihu in 2009. There are 54 villages in Caihu, of which 39 are immigrant and 15 host.

For this study, 572 immigrant families and 395 host families were selected using the method of random cluster sampling in Caihu. The study samples represented 4% of the immigrant families and 4% of the host families. All family members older than 18 years were interviewed using a specifically designed structured questionnaire. The face-to-face interviews were carried out by village doctors who received training as interviewers. The research protocol was approved by the Research Ethics Committee of Tongji Medical College, Huazhong University of Science and Technology.

Questionnaire

The questionnaire consisted of four sections: 1. questions on sociodemographic information such as sex, age, annual income, education and occupation; 2. lifestyle factors such as smoking habit, alcohol consumption and hot food intake; 3. living environment including separate kitchen, fuel for cooking, kitchen ventilation conditions and water source for drinking; 4. a simple frequency record the consumption of foods, including cereal, fresh meat, egg, fruits, vegetables, and salt intake.

Statistical analysis

All data were analyzed using SPSS software (Chicago, Illinois, USA). The data were expressed as percentage or mean ± standard deviation. The Chi-square test or Student t-tests were used to examine the differences between the two study populations. The standard statistically significant level for group comparisons was $P<0.05$.

Results

Sociodemographic characteristics

A total of 3,155 residents participated in the study survey. Among them, 1,791 were IR and 1,364 were HR. The sociodemographic characteristics of participants of the two groups are summarized in Table 1. The sex ratios in both groups were comparable. No differences were seen in the mean age and family income per year between the two groups. The majorities of both groups were farmers, and had a middle school education (8-9 years schooling).

Lifestyles

Data comparing the lifestyle of IR and HR is displayed in Table 2. Significantly greater consumption of alcohol ($P<0.05$) was observed among HR compared with IR. The consumption of cigarettes ($P>0.05$) was not significantly different between the two groups. A regular habit of eating and drinking very hot foods was observed in a higher proportion of IR compared with HR. A higher proportion of IR also regularly ate pickled vegetables ($P<0.05$).

Table 1. Summary of Demographics Characteristics of Host Residents and Immigrant Residents

	HR (1,364)	Freq (%)	IR (1,791)	Freq (%)	P-value
Sex					
Male	689	50.7	886	49.6	>0.05
Female	669	49.3	899	50.4	
Age (years)					
18-29	273	20.0	374	20.9	
30-39	356	26.1	462	25.8	>0.05
40-59	332	24.3	453	25.3	
60-	403	29.5	502	28.0	
Education					
No schooling	145	11.1	138	7.9	
Elementary school	425	32.4	443	25.3	
Middle school	584	44.5	867	49.4	<0.05
High school	134	10.2	244	13.9	
University	23	1.8	62	3.5	
Employment					
Farmers	1,106	84.8	1,308	75.1	
Workers	78	6	145	8.3	
Self-employed	47	3.6	108	6.2	<0.05
Student	34	2.6	82	4.7	
Others	40	3	98	5.7	
Family income					
<5,000	235	59.5	387	67.7	
5,000-9,999	92	23.3	105	18.4	
10,000-29,999	40	10.1	46	8.0	>0.05
30,000-49,999	7	1.8	5	0.9	
≥50,000	2	0.5	5	0.9	

Table 2. Comparison of Lifestyles between Host Residents and Immigrant Residents

	HR (1,364)	Freq (%)	IR (1,791)	Freq (%)	P-value
Smoking					
Yes	383	28.5	503	28.2	>0.05
No	959	71.5	1,280	71.8	
Alcohol drinking					
Yes	406	31.7	468	26.4	<0.05
No	874	68.3	1,306	73.6	
A regular habit of eat very hot foods					
Yes	1,139	84.1	1,587	88.8	<0.05
No	216	15.9	200	11.2	
A regular habit of eating pickled vegetables					
Yes	236	17.7	486	29.22	<0.05
No	1,100	82.3	1,177	70.78	

Dietary intake

The daily food intake was compared between IR and HR. Intake of fruits, vegetables, eggs, and meat was considerably lower in IR than in HR ($P<0.05$) (Table 3). A significantly higher intake of salt in IR was observed compared with the intake in HR ($P<0.05$).

Living environment

Data on the living environment of the two groups are displayed in Table 4. The proportion using tap water and having a kitchen was significantly higher in HR compared with IR ($P<0.05$). A significant difference was observed in the type of fuel for cooking between HR and IR ($P<0.05$) but not for ventilation mode in the kitchen.

Table 3. Comparison of Food Intake per Day Between Host Residents and Immigrant Residents

Food(g)	HR mean(SD)	IR mean(SD)	P-value
Cereal	343.7 (169.4)	316.0 (159.5)	<0.05
Fruits	251.2 (270.8)	204.5 (267.8)	<0.05
Vegetables	326.1 (207.0)	266.1 (206.1)	<0.05
Meat	105.2 (127.0)	71.9 (106.6)	<0.05
Salt	7.1 (3.5)	8.6 (4.3)	<0.05
Egg	134.7 (82.8)	60.6 (72.3)	<0.05

Table 4. Comparison of Living Environment Between Host Residents and Immigrant Residents

	HR (395)	Freq (%)	IR (572)	Freq (%)	P-value
Drinking water					
Tap water	309	78.2	329	57.5	<0.05
Shallow ground water	84	21.3	227	39.7	
Kitchen					
Have	380	96.2	512	89.5	<0.05
Not have	14	3.54	42	7.34	
Ventilation mode					
Mechanical ventilation	38	9.62	54	9.44	>0.05
Nature ventilation	348	88.1	502	87.8	
Chimney					
Have	378	96.4	491	88.6	<0.05
Not have	14	3.58	63	11.4	
Fuel					
Natural gas	94	23.8	69	12.1	
Coal	17	4.3	25	4.37	
Wood	213	53.9	369	64.5	<0.05
Straw	26	6.58	65	11.4	
Other	43	10.9	29	5.06	

Discussion

Our previous study demonstrated that migrants in Caihu persistently had a higher prevalence of ESCC compared with HR and maintained the same mortality rate as their native counterparts in Henan, even though they had lived in the low ESCC area for more than 40 years. It suggested that genetic susceptibility, rather than environmental exposure may be responsible for the high risk of ESCC in the migrants (Zhang et al., 2009). However, the migrants included in the study resettled in one town and formed a relatively isolated community, so that it was possible that they kept their traditional lifestyle, which could comprise potential risk factors for ESCC. Therefore, in this study, we investigated environmental factors that could contribute to the high risk of ESCC in migrants by comparing the lifestyle, diet and living environment between the immigrant and host population who lived in the same natural environment. The results showed that hot food, pickled vegetables, salt, and low fruit and vegetable intake, as well as a poor living environment, are possibly related to the higher prevalence of ESCC in IR.

A large number of case-control and cohort studies have demonstrated that cigarette smoking, alcohol drinking and interaction of tobacco smoking and alcohol drinking are strongly associated with ESCC (Yokokawa et al., 1999; Fan et al., 2008). However, our study found that the consumption of cigarettes was not different between IR and HR. In addition, the consumption of alcohol was significantly higher among HR than IR. These results suggested that cigarette smoking and alcohol drinking did not play a role in the differences in mortality of ESCC between the two populations. Our results were consistent with other research in high risk areas of China, which revealed that cigarette smoking and alcohol drinking were not risk factors or were minor risk factors for ESCC (Cook-Mozaffari et al., 1979; Tran et al., 2005; Nasrollahzadeh et al., 2008). It implied that other strong risk factors existed in this migrant population.

ESCC has been considered a disease of the poor and the socially disadvantaged for some time. However, our study showed that there was no difference in the annual income between IR and HR, and more IR than HR received a higher education. These findings contrasted with most studies done so far, which have reported an increased risk of 2-4 times among those with lower compared with higher socioeconomic status (Ahmed et al., 1992; Brown et al., 2001; Wei et al., 2005). During the last few decades, with China's rapid economic development, the socioeconomic status of both IR and HR has improved greatly, but the mortality rate of ESCC in IR has remained the same magnitude as when they had just resettled in Caihu (Zhang et al., 2009). It suggested that low socioeconomic status may not be a major risk factor for ESCC in this population.

The IR displayed an adverse risk profile with regard to unhealthy dietary factors, such as high intake of pickled vegetables and hot food, and low intake of fresh fruits and vegetables. Pickled vegetables have been a popular food in migrant families and are eaten daily throughout the year as a major part of the diet. These findings were consistent with other case-control or ecological studies. A high intake of pickled vegetables has long been considered as a possible risk factor for ESCC in high incidence areas. Studies have shown that pickled vegetables and their fluid were mutagenic, and could induce cancer when fed to rats (Cheng et al., 1980; Yang, 1980; Lu et al., 1981). Low intake of fresh vegetables has been implicated as a principal factor in the etiology of ESCC. It is estimated that high intake of fruits and vegetables probably decreases the risk of ESCC by about 20% per 50 g of fruit or vegetable intake per day (World Cancer Research Fund, 2007).

Consumption of rice gruel at high temperature was a distinct dietary habit among IR We observed a significantly higher intake of 'hot food' especially hot rice gruel among IR compared with HR. This epidemiological pattern was also observed in Linxian, which is one of the areas with highest incidence of ESCC in world. Many studies in that area found that the high temperature of food was a strong risk factor for ESCC (Munoz et al., 1982; Garidou et al., 1996; Castellsague et al., 2000). A recent population-based case-control study in North Iran revealed that very hot tea (>65°C) increased the risk of ESCC by 8.16 times (Islami et al., 2009). So far, hot food or drink has been determined as the universal risk factor for ESCC in different high risk areas of the world.

The quality of indoor air of immigrant families was poorer than that of host families, and more used polluted fuel for cooking, and cooked at home without a separate kitchen. One study showed that cooking with polluted fuel and without a separate kitchen increased the concentration

of some mutagenic substances, such as polycyclic aromatic hydrocarbons (PAH) and benzo(a)pyrene (Hakami et al., 2008). Another study in northeastern Iran found a high concentration of urinary marker of PAHs in ESCC patients and residents of those areas (Kamangar et al., 2005).

Shallow groundwater (including well water and pool water) is often polluted with nitrogen compounds, and is significantly associated with a high incidence of ESCC (Yokokawa et al., 1999). The proportion using shallow groundwater among HR compared with IR was significantly different. Less than 60% of IR used tap water in their daily lives and the rest used well water and pond water. However, we found that HR only began to use tap water in the last 2-3 years, and they also previously used well water and pond water as the IR did. It therefore seemed unlikely that this had an effect on ESCC mortality in such a short time. Analysis of the effect of the improvement in drinking water sanitation on the prevalence of ESCC is required in a future study.

Our study demonstrated that diet, cooking habits and the living environment of IR remained similar to the custom in their original area. Residents in the original areas tended to build a house without a kitchen, or use polluted fuel for cooking for some geographical or cultural reasons. The differences in some of these characteristics may partially explain the high risk of ESCC among IR. More comprehensive and larger-scale studies concerning the role of hot food, pickled vegetables, and the poor quality of indoor air in the etiology of ESCC are needed.

It should be noted that the second-generation immigrants (<40 years) born in the host region have not yet reached the high risk age for ESCC. We observed that second-generation migrants (data not shown) assimilated the lifestyle and living environment of the HR. Future studies are needed to focus on the association of lifestyles and living conditions of second-generation immigrants with their ESCC morbidity and mortality.

Acknowledgements

NECT program 07-0333 and NSFS No. 30671733.

References

Ahmed WU, Qureshi H, Alam E, et al (1992). Oesophageal carcinoma in Karachi. *J Pak Med Assoc*, **42**, 133-5.

Brown LM, Hoover R, Silverman D, et al (2001). Excess incidence of squamous cell esophageal cancer among US Black men: role of social class and other risk factors. *Am J Epidemiol*, **153**, 114-22.

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.

Cheng SJ, Sala M, Li MH, et al (1980). Mutagenic, transforming and promoting effect of pickled vegetables from Linxian county, China. *Carcinogenesis*, **1**, 685-92.

Cook-Mozaffari PJ, Azordegan F, Day NE, et al (1979). Oesophageal cancer studies in the Caspian Littoral of Iran: results of a case-control study. *Br J Cancer*, **39**, 293-309.

Falk GW (2009). Risk factors for esophageal cancer development. *Surg Oncol Clin N Am*, **18**, 469-85.

Fan Y, Yuan JM, Wang R, et al (2008). Alcohol, tobacco, and diet in relation to esophageal cancer: the Shanghai cohort study. *Nutr Cancer*, **60**, 354-63.

Garidou A, Tzonou A, Lipworth L, et al (1996). Life-style factors and medical conditions in relation to esophageal cancer by histologic type in a low-risk population. *Int J Cancer*, **68**, 295-9.

Hakami R, Mohtadinia J, Etemadi A, et al (2008). Dietary intake of benzo(a)pyrene and risk of esophageal cancer in north of Iran. *Nutr Cancer*, **60**, 216-21.

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**, b929.

Kamangar F, Chow WH, Abnet CC, et al (2009). Environmental causes of esophageal cancer. *Gastroenterol Clin N Am*, **38**, 27-57.

Kamangar F, Strickland PT, Pourshams A, et al (2005). High exposure to polycyclic aromatic hydrocarbons may contribute to high risk of esophageal cancer in northeastern Iran. *Anticancer Res*, **25**, 425-8.

Li JY (1982). Epidemiology of esophageal cancer in China. *Natl Cancer Inst Monogr*, **62**, 113-20.

Li W, Lu W, Zhu M, et al (1998). Determination of copper, zinc, iron and calcium in wheat and maize and three nitrogen compounds in high and low risk areas of esophageal cancer. *Wei Sheng Yan Jiu*, **27**, 69-71.

Lu SH, Camus AM, Tomatis L, et al (1981). Mutagenicity of extracts of pickled vegetables collected in Linhsien county, a high-incidence area for esophageal cancer in Northern China. *J Natl Cancer Inst*, **66**, 33-6.

Montesano R, Hall J (2001). Environmental causes of human cancers. *Eur J Cancer*, **37**, S67-87.

Munoz N, Crespi M, Grassi A, et al (1982). Precursor lesions of oesophageal cancer in high-risk populations in Iran and China. *Lancet*, **1**, 876-9.

Nasrollahzadeh D, Kamangar F, Aghcheli K, et al (2008). Opium, tobacco, and alcohol use in relation to oesophageal squamous cell carcinoma in a high-risk area of Iran. *Br J Cancer*, **98**, 1857-63.

Szumilo J (2009). Epidemiology and risk factors of the esophageal squamous cell carcinoma. *Pol Merkur Lekarski*, **26**, 82-5.

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.

Wei WQ, Abnet CC, Lu N, et al (2005). Risk factors for oesophageal squamous dysplasia in adult inhabitants of a high risk region of China. *Gut*, **54**, 759-63.

World Cancer Research Fund (2007). Food, nutrition, physical activity and the prevention of cancer - a global perspective, 1. Washington DC: AICR.

Wu M, Zhao JK, Hu XS, et al (2006). Association of smoking, alcohol drinking and dietary factors with esophageal cancer in high- and low-risk areas of Jiangsu Province, China. *World J Gastroenterol*, **12**, 1686-93.

Xibin S, Moller H, Evans HS, et al (2002). Residential Environment, Diet and Risk of Stomach Cancer: a Case-control Study in Linzhou, China. *Asian Pac J Cancer Prev*, **3**, 167-72.

Xu XC (2009). Risk factors and gene expression in esophageal cancer. *Methods Mol Biol*, **471**, 335-60.

Yang CS (1980). Research on esophageal cancer in China: a review. *Cancer Res*, **40**, 2633-44.

Yokokawa Y, Ohta S, Hou J, et al (1999). Ecological study on the risks of esophageal cancer in Ci-Xian, China: the importance of nutritional status and the use of well water.

Lifestyle and Living Environment of High Risk Immigrant and Low Risk Host Residents: Implications for Esophageal Cancer Int J Cancer, **83**, 620-4.
Zhang H, Chen Z, Cheng J, et al (2009). The high incidence of esophageal cancer in parts of China may result primarily from genetic rather than environmental factors. *Dis Esophagus*, **23**, 392-7.