Letter to the Editor

Spatial Distribution of Liver Cancer Incidence in Shenqiu County, Henan Province, China: a Spatial Analysis*

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Liver cancer is a common and leading cause of cancer death in China. We used the cancer registry data collected from 2009 to 2011 to describe the spatial distribution of liver cancer incidence at village level in Shengqiu county, Henan province, China. Spatial autocorrelation analysis was employed to detect significant differences from a random spatial distribution of liver cancer incidence. Spatial scan statistics were used to detect and evaluate the clusters of liver cancer cases. Spatial clusters were mapped using ArcGIS 10.0 software in order to identify their physical location at village level. High cluster areas of liver cancer incidence were observed in 26 villages of 7 towns and low cluster areas were observed in 16 villages of 4 towns. High cluster areas of liver cancer incidence were distributed along the Sha Ying River which is the largest of tributary of the Huai River. Role of water pollution in Shenqiu County where the high cluster was found deserves further investigation.

Liver cancer is the fifth most common cancer in men (523,000 cases, 7.9% of the total) and the seventh in women (226,000 cases, 3.7% of total) in the world, and most of the burden is in developing countries, where almost 85% of the cases occur, and particularly in men. High incidence areas are Eastern and South-Eastern Asia, Middle and Western Africa. There were an estimated 694,000 deaths from liver cancer in 2008, 477,000 in men and 217,000 in women and because of its high fatality, liver cancer is the third most common cause of death from cancer worldwide[1]. Liver cancer is second leading cause of cancer death since 1990s in China[2-4]. In this study,

we analyzed the data of liver cancer incidence for the years from 2009 to 2011 in Shenqiu county, Henan province. The county-level data were obtained from Shenqiu county cancer registry database. Liver cancer incidence was stratified and calculated by gender, age and geographic location. Spatial cluster analyses involving spatial autocorrelation analysis and spatial scan statistic were used to identify geographic distribution patterns of liver cancer cases at the village level. We hypothesized that water pollution may play a critical role in driving liver cancer incidence and clustered distribution in this region. The study investigates how these risk factors associated with geographic distribution of liver cancer cases.

Liver cancer cases diagnosed between January 2009 to December 2011, were reported to local cancer registry from all hospitals, community health centers, other departments including centers of township medical insurance and New-type Rural Cooperative Medical System. Vital statistics were linked and matched with the cancer registry database for identifying missed cases. Cancer registry can capture more than 95% newly diagnosed cases. All patients were verified to be local residents who had lived in Shenqiu county for more than 5 years. Personal information for patients were collected including ID of registry, gender, current residential address, date of birth, occupational history, date of diagnosis, hospital where the diagnosis was made. The cancer registry coded cancer site and histology according to the International Classification of Disease for Oncology, tenth edition (ICD-10).

County-level data of liver cancer incidence was evaluated by following Guideline of Chinese Cancer Registry and standards of data inclusion in 'Cancer Incidence in Five Continents Volume IX'[5]. Cancer registry data were evaluated by following indicators of data quality including proportion of morphologic verification (MV%), percentage of cancer cases identified with death certification only (DCO%) and mortality-to-incidence ratio (MI). The detailed standards for data inclusion including overall DCO% less than 20%, MV% more than 55% and M/I between 0.55 and 0.95 were considered acceptable.

Exploratory spatial data analysis was used to conduct spatial statistical analyses for liver cancer incidence at village level[6]. Spatial autocorrelation methodologies including global Moran's I and local Getis-Ord statistics were used to describe and map spatial clusters. Global Moran's I was used to describe overall spatial clustering of towns and villages observed and to measure the correlation among neighboring villages and to identify patterns and levels of spatial clustering among neighboring villages. The Moran's I was calculated by Formula 1-2:

$$I = \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} (X_i - \overline{X})(X_j - \overline{X})}{S^2 \times \sum_{i=1}^{n} \sum_{j=1}^{n} W_{ij}} \quad (1)$$

$$S^2 = \frac{1}{n} \sum_{i=1}^{n} (X_i - \overline{X})^2, \quad X = \frac{1}{n} \sum_{i=1}^{n} X_i \quad (2)$$

where, the n is number of villages observed (total 574 villages were observed); W_{ij} is spatial weight that defines neighboring village i to j; X_i and X_j are observations (incidence) for villages of i and j; if $\sum X_{ij}$ = 1, spatial autocorrelation analysis is to construct a spatial weight that contains information about the neighborhood structure for each location. Non-neighboring is given a weight of zero. Local Getis's G_i^* (local Getis-Ord statistics) can be used to be a model for description of correlation and clustering of individual village and neighboring villages and for detecting hotspots of clustering. G_i^* can be calculated by Formula 3-4:

$$G_i^* = \frac{\sum_{j=1}^{n} W_{ij}(d) X_j - W_j^* \overline{X}}{S \sqrt{(n S_{1i} - W_i^{*2})/(n-1)}} \quad (3)$$

$$W_i^* = \sum_{j=1}^{n} W_{ij}, \quad S_{1i} = \sum_{j=1}^{n} W_{ij}^2 \quad (4)$$

where, S is the standard variations of liver cancer incidence; W_{ij} is spatial weight that defines neighboring village i to j; The higher the value of G_i^* indicates that village i is a hotspots of the region. G_i^* can be calculated as a standard normal variant with an associated probability from the z-score distribution. Clusters with a 95 percent significance level from a two-tailed normal distribution indicate significant clustering spatially, and the significant clusters (the z-score value ranges -1.96 to +1.96) are mapped. Spatial clusters were mapped using ArcGIS 10.0 software in order to identify their physical location at village level[7].

Liver cancer incidence were calculated by gender, age (total 19 age groups, <1, 1-4, 5-9 … 81-84, ≥85 years) and geographic location. Age-standardized rates were calculated using Chinese population in 2000 and world population in 2000. The cumulative risk of development from liver cancer before 75 years of age (in the absence of competing causes of death) was calculated and presented as a percentage. SAS 9.2 software was used to calculate the incidence rates.

As shown in Figure 1, Huai River is located in the mid-way between Yellow River and Yangtze River, and flows from West to East through Henan, Anhui, Shandong, and Jiangsu provinces with a length of 1078 kilometers. Shenqiu county, Henan province is situated on the Sha Ying River which is the largest of tributary of the Huai River. Population of Shenqiu county are 1,230,000 for the year of 2012.

Liver cancer incidences during 2009 to 2011 were summarized in Table 1. Total of 1389 newly diagnosed liver cancer cases were ascertained from Shenqiu county cancer registry database including 1028 males and 361 females. Liver cancer incidence was 40.48/100,000, 59.12/100,000 in male, and 21.33/100,000 in female, respectively. Liver cancer incidence in Chinese rural registration areas was 28.71/100,000 in 2009, 41.99/100,000 in male and 15.11/100,000 in female, respectively[8]. Liver cancer incidence was stratified and calculated by the year to show a significant difference (X^2=10.96, P=0.0042).

Liver cancer incidence was stratified and calculated by 19 age groups (<1, 1-4, 5-9 … 81-84, ≥85 years). Liver cancer incidence was highest in the age group of 55-60 years old, there are about 2.5 times high in male than that in Chinese rural registration areas in 2009 (Figure 2).

Liver cancer incidence was stratified and calculated by geographic location to identify high incidence areas. Liver cancer incidence was found higher in 6 towns including Zhaodeyin, Fujing, Zidian, Zhouying, Fanying, and Shichao towns and lower in 3 towns including Xingzhuang, Xinanji, and Hongshan towns.