RESEARCH ARTICLE

Study on Theoretical Models of Regional Humanity Lung Cancer Hazards Assessment

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Abstract

Purpose: To establish the concept of lung cancer hazard assessment theoretical models, evaluating the degree of lung cancer risk of Beijing for regional population lung cancer hazard assessment to provide a basis for technical support. Materials and Methods: ISO standards were used to classify stratified analysis for the entire population, life cycle, processes and socioeconomic management. Associated risk factors were evaluated as lung cancer hazard risk assessment first class indicators. Study design: Using the above materials, indicators were given the weight coefficients, building lung cancer risk assessment theoretical models. Regional data for Beijing were entered into the theoretical model to calculate the parameters of each indicator and evaluate the degree of local lung cancer risk. Results: Adopting the concept of lung cancer hazard assessment and theoretical models for regional populations, we established a lung cancer hazard risk assessment system, including 2 first indicators, 8 secondary indicators and 18 third indicators. All indicators were given weight coefficients and used as information sources. Score of hazard for lung cancer was 84.4 in Beijing. Conclusions: Comprehensively and systematically building a lung cancer risk assessment theoretical model for regional populations in conceivable, evaluating the degree of lung cancer risk of Beijing, providing technical support and scientific basis for interventions for prevention.

Keywords: Lung cancer - hazards assessment - index system - theoretical models

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Introduction

Lung cancer has become a global major public health problem which was harmful to human health (Stewart et al., 2014) and caused by multiple risk factors, including social and environmental factors, unhealthy behaviors and lifestyle. Smoking and long-term exposure to air pollution is the main factor increasing the risk for lung cancer. There were some specific, service and managed research on local courses and fields among the past research, but often lacking of comprehensive and systematic risk assessment studies and theoretical models studies.

Thus they were unable to clarify the severity of its risk and to carry out a quantitative assessment. In addition to certain countries, the effect of prevention and treatment of lung cancer is not obvious especially in developing countries. The risks of lung cancer among majority of developing countries were increasing. To establish the theoretical models of lung cancer hazard assessments, evaluating the degree of lung cancer risk of Beijing, providing the basis and technical support for regional population lung cancer hazard assessment and the scientific understanding of lung cancer hazards to reduce risks and protect human health.

Materials and Methods

Reference

Risk assessment was made according to IEC/ISO 31010:2009 risk assessment criteria (ISO, 2009). Public health risk assessment was made according to WHO "reduce the risk and emergency preparedness" (Cluster et al., 2006). Lung cancer risk assessment was according to the WHO "Cancer Control: Knowledge into action" 2005-2008 (WHO, 2005-2008). Therefore, the theoretical model of lung cancer was composed by three criteria above, as to indicators system framework and rating criteria.

Objective

The primary perspective is that of health care, which included majority of statistical information including 2005-2013 year population mortality among Beijing,at-risk populations, incidence or prevalence of lung cancer and healthy population. The lung pathological observation information including squamous cell carcinoma, adenocarcinoma and small cell lung cancer, pathological stage (stage 0-IV). The society factors included socioeconomic, environmental, behavioral and biological aspects.

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Material

This analysis is based on data from "2014, 2008 and 2003 WHO World Cancer Report", "2013 IARC air pollution and cancer research reports", "2005-2013 Chinese cancer registry annual report", "Report on 2009-2013 health and population health status in Beijing", "2012 Sunshine Wall: lung cancer prevention and action in Beijing", etc. A subset of these was used to construct the original risk model.

Methods

Standard Method: Based on ISO risk assessment standards, WHO public health risk assessment criteria and lung cancer risk assessment methods, we proposed to define the risk of lung cancer, the theory and framework of indicators, including: the hazards, vulnerability, prevention and control capabilities. Hazards are divided into risk factors and severity.

Review: Global, European Organization for Economic Cooperation (OECD), China and Beijing lung cancer related information and reports were analyzed for classification to identify cancer risk factors, clinical features, histopathological observation, the causal relationship and hazard risk control points.

AHP: The lung cancer risk factors and their severity for whole population were stratified analysis, seeking to risk factors level and various stages of disease ranging from development to death, which analyzed interaction between these and attributable risk.

Study Design

Using the above materials, establishing lung cancer hazard risk assessment indicator system, the whole indicators were given the weight coefficients, building a lung cancer risk assessment theoretical models.Take the regional data in Beijing into the theoretical model to calculate the parameters of each indicator and the result risk of Beijing, evaluating the degree of lung cancer risk of Beijing.

Results

Lung Cancer Hazard Assessment and theoretical models

Risk referred to the effect of something being risk factors coming to damage or unexpected events, namely the probability of an event occurring. The probability of the public health risk factors was increasing depending on cause of disease or injury, we often told it health risk factor. The serve of the public health risk is determined by three factors, including hazard, vulnerability and prevention capability. Expressed by equation, the risk of hazard was equal to vulnerability multiplied by prevention capability. The more serious hazard would be, the greater vulnerability was increasing, the weaker prevention and control capacity would have, the greater the risk of disease would be. The public health risk assessment model for:

$$\text{Public health risk(R)}=\frac{\text{Hazard(H)* Vulnerability(V)}}{\text{Capability(C)}}$$

The risk represented by R, Hazard represented by H, Vulnerability represented by V, Capability represented by C, the lung cancer risk assessment model for:

$$\text{Lung cancer risk(LCR)}=\frac{\text{Lung Cancer(LCH)* Lung Cancer Vulnerability(LCV)}}{\text{Lung Cancer Capability(LCC)}}$$

Thus, regional lung cancer risk assessment model formula was established depending on above four factors:

$$R'_j = \text{In}\left(\frac{\chi'_h \times \chi'_v}{\chi'_c}\right)$$

(R^y_j : the regional score of lung cancer risk c^y_h: the regional score of lung cancer hazard c^y_v: the regional score of lung cancer vulnerability c^y_c: the regional score of lung cancer prevention capabilities)

In the case of vulnerability and prevention capacity approached to zero, the hazards and risks would be equal, which namely hazards were risks that can be called the hazards of risk assessment. Lung cancer assessment related to social, environmental, behavioral and genetic factors that influence on long-term interaction with genetic factors, which effected on lung cancer gene mutations, abnormal cell proliferation and the whole population and entire life cycle. The formula was:

$$\chi_h = \sum_{i=1}^{n_i} w_{i,h}\,\chi_{i,h}$$

(χ_h the score of lung cancer hazard indicators $\chi_{i,h}$ the score of the fourth indicators of lung cancer hazard indicators $w_{i,h}$ the weight coefficient of lung cancer hazard, Ni the quantity of lung cancer hazard indicators)

According to the index system and assessment criteria, when evaluating the hazards of a regional population of lung cancer, all indicators were scoring and given the weight coefficients. Then using the regional population hazards of lung cancer risk assessment formula was calculating weighted scores to evaluate of regional population hazard risks.

Indicators system for theoretical model

Based on lung cancer related data information of global, OECD, China and Beijing for determining lung cancer hazard and risk factors affected the populations' health (Colditz et al., 2000; Spitz et al., 2007; Spitz et al., 2008;Cassidy et al., 2008). Establish hazards assessment of lung cancer index system according to ISO risk assessment standard as the first class indicator (Table 1: The lung cancer hazard assessments indicators system framework and rating criteria).

The first indicator: Based on WHO Public health risk assessment guidelines, the hazards of lung cancer can be divided into risk factors and severity indicators.

The second indicator: Risk factors were divided into the social healthy determinants, environmental and behavioral risk factors, lifestyle risk factors and others. The severity was divided into epidemiology, clinical stage, histopathological observation, carcinogenic mechanisms and recoverability, which form of the second indicators of lung cancer.

The third indicators: The social determinants of health can be divided into income levels, education levels,

the level of population growth, urbanization degree, industrialization degree, the total energy and vehicle ownership, etc. The environmental risk factors can be divided into air pollution and fog haze. The behavioral risk factors can be divided into smoking, lacking of exercise and mental stress. Epidemiological indicators can be further divided into morbidity, mortality. Clinical features can be further represented by a clinical stage. Histopathological observation was classified by pathology. Pathogenesis of diseases can be classified according to the different type of risk factors. Recoverability can be divided into reversible and irreversible. The third indicators of hazards of lung cancer risk assessment were made up these indicators together, and thus further subdivided into fourth indicators.

Determinants of hazard indicators

Determinants of risk factors

Social determinants of health

Social determinants of health can be further divided into the economy (WHO, 2008), culture (WHO, 2010), education, population, urbanization (Cohen et al., 2004; Pruss-Ustun., 2006), industrialization, energy and vehicle ownership (Garshick et al., 2008) indicators. These could directly affect people's social status and fairness and accessibility of health care resources, but also indirectly affect human health including development and progression of lung cancer. In the generally, the total GDP, per capita GDP were used to measure the level of economic development. While, use the illiteracy rate and education measured level of education. Total population and population density were measured to describe demographic conditions. The rate of urbanization and urban zoning were measured to assess degree of urbanization. Used the Huffman coefficient measured the degree of industrialization. Use the number of motor vehicles to measure vehicle pollution situation. Measure the total energy production with the extent of environmental pollution, which reflected a country or region social determinants of hazards level of lung cancer.

Environmental risk factors

IARC have reported (Straif et al., 2013) that air pollution, fog haze would directly or indirectly increase human lung cancer morbidity or mortality which contributed to human lung cancer death rate about 8% (WHO, 2009). The total suspended particulate air pollution (TSP), respirable particulate matter (PM10) and fine particulate matter (PM2.5), which contained benzopyrene, hexavalent chromium, arsenic and its compounds, mutagens, teratogens and other harmful substances, so that did increase number of incidence lung cancer significantly (Pope et al., 2002; Yang et al., 2005; Cui et al., 2009). Currently, using the average concentration of PM2.5/per year reflected environmental risk factors (Pongpiachan et al., 2013). When PM2.5 air concentrations increased each additional 10μg/m3, the incidence of lung cancer would increase 1.29-fold (Hystad et al., 2013). Since 2013, fog haze was frequently in China and PM2.5 average concentration was high over 150μg/m3, greatly harmed the health of population, in particular caused lung cancer.

Behavioral risk factors

Smoking (Zeegers et al., 2000; WHO, 2004; Wang et al., 2008; Hwang et al., 2013), lacking of physical activity(Sun et al., 2012) and mental stress(WHO, 2010) were all the main risk factors of lung cancer increased incidence hazards. Where smoking is the primary risk factor for lung cancer, the active and passive smoking rate were available to assess the target population which contributed to lung cancer death rate about 71% (WHO, 2009). Lacking of physical activity (WHO, 2009) and available psychological pressure rates were used lacking of physical activity rate and psychological disorders as population indicators.

Severity determinants

Epidemiological characteristics: The incidence, mortality and rank order of causes of death were epidemiological indicators to evaluate the severity of lung cancer, based on WHO chronic non-communicable diseases evaluation methods as (1/100,000) a unit, compared with no matter what countries incidence and death situation comprehensively and systematically.

Clinical Features

According to the United States "Non-Small Cell Lung Cancer, NSCL" and Ministry of health of the people's republic of China "primary lung cancer clinical diagnostic and treatment guideline", clinical features can be represented by the clinical stage. They were carried out in accordance with TNM stage, T for the primary tumor, N for regional lymph nodes, M for distant metastasis, therefore lung cancer can be divided into invisible lung, 0, I, II, III and IV stage.

Histopathological observation

According to WHO the degree of differentiation and morphological characteristics of various types of lung cancer, which were divided into two categories, including small cell lung cancer (SCLC) and non-small cell lung cancer (NSCLC), the latter consisted of squamous cell carcinoma, adenocarcinoma and large cell carcinoma. Early (IA) (Ahmed et al., 2013) five-year survival rate can reach 70% for non-small cell lung cancer. However, the overall five-year survival rate was only 5% for small cell lung cancer, the average 5-year survival in patients with advanced was less than 1% (Minna et al., 2008).

Carcinogenic mechanisms

Lung squamous cell carcinoma (LSCC) was a kind of malignant epithelial tumors derived from bronchial epithelial, it may show keratosis and/or intercellular bridge features. Spindle cell carcinoma was the most common and accounted for 40%-50% of primary lung cancer, of which more than 90% occurred in smokers. Lung adenocarcinoma (LAC) related to air pollution, more likely to occur in women and non-smokers. Its incidence was lower than squamous cell carcinoma and

Table 1. The Lung Cancer Hazard Assessments Indicators System Framework and Rating Criteria

One class	first	second	Third	Stalls divided	Situation in Beijing	Score	Weights	Result score
HAZARD	Risk fact	Determinants of socio-economic structure	H1.1 regional per capita income levels, (U.S. $)		$ 12,447	25	0.02	0.5
			H1.2 region illiteracy rate,%		1.7%	25	0.01	0.25
			H1.3 population density, people / sq km		1195 people / sq km	100	0.02	2
			H1.4 average annual growth rate of urbanization,%		1.085%	75	0.01	0.75
			H1.5 Hoffman ratio		1.5	50	0.01	0.5
			H1.6 total energy production (million tons)		3.3 billion tons	100	0.01	1
			H1.7 vehicle ownership, (10000)		5400000	100	0.02	2
		Environmental factors	H2.1 annual fog haze weather, (number of days)		124 days	100	0.05	5
			H2.2 PM2.5 annual average concentrations, (μg/m3)		89.5μg/m3	100	0.05	5
		Behavioral factors	H3.1 smoking rate,%		29.4%	75	0.315	23.625
			H3.2 crowd lack of physical activity rate,%		31.7%	50	0.0175	0.875
			H3.3 population prevalence of mental illness,%		15.9%	25	0.0175	0.4375
	Severity	Epidemiology	H4.1 crowd lung cancer mortality, / 100000		56.36/ 100000	100	0.05	5
			H4.2 population incidence of lung cancer, / 100000		63.09/ 100000	100	0.05	5
		Recoverability	H4.3 lung cancer is reversible or not		Irreversible	100	0.1	10
		Clinical features	H4.4 pathogenesis of lung cancer		adenocarcinoma	100	0.1	10
		Pathology	H4.5Lung pathological characteristics		Non-small-cell	50	0.1	5
		Clinical stage	H4.6 clinical staging of lung cancer		III	75	0.1	7.5

undifferentiated carcinoma and younger would more likely to develop, accounting for primary lung cancer by 40%. Small cell lung cancer (SCLC) was closely related to smoking, accounted for lung cancer about 20%.

Recoverability

lung cancer diagnosis based on WHO criteria, 0 and Istage though surgical resection would be completely cured. Otherwise, the other types of lung cancer were considered unrecoverable.

Weight coefficients for theoretical model

According to domestic and foreign Meta-analysis of the results of lung cancer-related literature, identified by RR values, OR value as quantitative indicators of lung cancer risk factors. While expert analysis and Delphi method as qualitative indicators determined. Above all determined first, second, third and fourth indicators respectively and weight coefficients. The hazards were first indicator and set to score 100 based on ISO, whose weighting factor was 1.

The first indicator: according to WHO public health risks, the lung cancer risk factors and severity were the assigned by 50 points, each weighted coefficient of 0.5.

The secondary indicators: the contribution of risk factors for lung cancer morbidity and mortality: the social risk factors were 20%, the environmental risk factors were 10%, behavior risk factors were 70%. The social risk factors was assigned to 10 points. The environment risk factors were assigned to 5 points. Behavioral risk factors were assigned to 35 points. The contribution of severity for lung cancer at different levels of morbidity and mortality included epidemiology, clinical features, pathology, pathogenesis and reversible reaction from different aspects, respectively assigned to 10 points.

The third indicators: data and information sources were collected and divided relevant to three indicators according to WHO, OECD and literature to identify criteria to determine the levels.(Table 1: The lung cancer hazard assessments indicators system framework and

rating criteria)

Evaluation the hazard of lung cancer risk in Beijing

Use the regional population of lung cancer hazard assessments theoretical model formula and combined with data sources in Beijing and divided into the different levels to calculate score of lung cancer risk. It shows that the hazards of lung cancer risk population in Beijing was 84.4375, lung cancer had a significant risk of harm.

Discussion

The purpose and significance of regional population lung cancer risk assessment: Over the years, human society has always unswervingly stick to study of lung cancer prevention, diagnosis, treatment, prevention and control, the majority were from their respective disciplines and administrative advance, however were rarely assessed the long-term interactions between the socio-economic, environmental pollution and fog haze weather, bad behavior and lifestyle, genetic factors, especially lung cancer. The purpose and significance of regional population lung cancer risk assessment is to identify the risk size and risk point of the area.Then build a comprehensive system of assessment methods to provide a comprehensive and scientific effectively recognized the hazards of discipline and find the prevention and control measures to provide theoretical support for all government.

The theoretical basis of regional population lung cancer risk assessment: The lung cancer risk assessment of regional population base on risk, public risk and the special risk of cancer. Lung cancer risk refers to the probability of human exposure to harmful risk factors to cause lung cancer,it is the possibility of lung cancer casused by the multiple health risk factors of long-term interaction inhealthy population, high risk population exposed,.The serve of risk is determined by three factors, including hazard, vulnerability and prevention capability. Expressed by equation, the risk of hazard was equal to vulnerability multiplied by prevention capability. The more serious hazard would be, the greater vulnerability was increasing, the weaker prevention and control capacity would have, the greater the risk of disease would be.

In the case of vulnerability and prevention capacity approached to zero, the hazards and risks would be equal, the hazards of risk assessment to establish a theoretical model of lung cancer involved the whole population, the whole life cycle and whole process of disease contacting different risk factors to surveillance and evaluation. Then build a comprehensive system of assessment methods to provide a comprehensive and scientific effectively recognized the hazards of discipline and find the prevention and control measures to provide theoretical support for all government.

The key points of lung caner hazard theoretical model: Firstly, the theoretical model evaluation method is scientific and effective.This study based on international standards and combined with practical and theoretical models to propose the risk factors theoretical model of lung cancer hazards. According to severity of disease and risk factors, classify all indicators by hierarchical stepwise selection. Evaluated scores obtained from regional health statistics and health information reports, socioeconomic annual report, social development index report, international health information statistics and major disease reports. This method can be carried out the risk population with cancer hazard analysis in different countries and cities to find out similarities and differences and the reasons for the difference. To find out the key hazards of lung cancer risk priority control points, provide effective control strategies for scientific basis.

Secondly,establish scientific indicators and assessment criteria. Based on the evaluation system, each indicator was summated to calculate the score of regional population lung cancer hazards. The higher the score was, the higher their risk of lung cancer hazards were. Its value from 0 to 100 which 100 was the highest risk and zero was risk-free.

Thirdly, To set up a software regarding the lung cancer hazard risk assessment of regional population according to theoretical model, effectively analyze the difference in data of different regions, improve efficiency, and reach a basis for risk prediction.

Evaluating the regional population lung cancer hazard assessment for Beijing at first time: As the capital of China, Beijing has growing morbidity and mortality concerning malignant tumor year by year, and lung cancer ranked first. According to the theoretical moble of lung cancer hazard, collect, process and grade the indicators of Beijing area, calculate the risk scores by using the formula, and then conclude that the hazard of lung cancer in Beijing area is in high risk level. Therefore, the improvement of social concern and attention is needed, provide theoretical support for the government to coordinate, control, and make policies and measures of prevention.

Prospect: WHO report showed that all kinds of causes resulted in different income groups, health inequality between countries, which included the economic income, rights, status, uneven distribution of products and services, medical health care, culture, levels of education, place of work and life, living conditions, community environment, urban and rural environment, the opportunity to enjoy a variety of life. All these were present injustice. So that resulted in smoking, drinking, lacking of physical activity and unhealthy life behavior were usually obvious. Thus, social determinants are the most elementary and important risk factors of choronic non-communicable diseases, but it have not been known and valued by the government administration and masses. If people want to reduce the harm that diseases bring human to the minimum, the elementary measures are needed, the government should enact relevant policy, system and laws, improve the economy, education and culture level of the masses, reduce the difference between person and person, reduce the unfair and unjust phenomenon. To achieve that everyone is equal, everyone enjoys health, everyone enjoys the primary health care, improve the overall health level of population, and create a better future

Summary: This article first putted forward the concept of regional population lung cancer risk assessment, including theoretical model, indicators system, evaluation standard and determined factors. Indicators system

included 2 first indicators, 8 secondary indicators and 18 third indicators, as well as 18 forth indicators corresponding to the third. The whole indicators were given the weight coefficients and used as information sources. Based on the contribution degree of lung cancer risk, total score was 100 points. Establish the regional population lung cancer hazard assessments theory and technical method to calculate the hazards of lung cancer was 84.4375 in Beijing, belonged to the great risk.

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