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Investigation and analysis of influencing factors of Pulmonary Nodules in Jinzhou City

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Abstract

This study aimed to assess Jinzhou city enterprise or business unit on-the-job worker pulmonary nodules disease status and related influencing factors to investigate, analyze its risk factors, early evaluation of pulmonary nodules, in order to achieve early screening and discovery early intervention, targeted for health education and health guidance, change the lifestyle, improve the quality of life, and to achieve the effect of disease prevention. The convenience sampling method was adopted to select the in-service employees of Jinzhou enterprises and public institutions who underwent physical examination in the Health Management Center of the First Affiliated Hospital of Jinzhou Medical University from October 2023 to May 2024 as the research objects. The pulmonary nodules risk factor assessment questionnaire was used for investigation, and SPSS 23.0 software was used for data entry. Descriptive analysis, Chi-square test and binary Logistic regression were used to analyze the data. A total of 1350 questionnaires were sent out and 1300 were effectively received with effective recovery rate of 96.29%. LDCT examination found that 569 patients had pulmonary nodules of different conditions, accounting for 43.77% of the total number. The detection results of pulmonary nodular density showed that 382 cases were solid nodules, accounting for 29.38% of the total number of patients detected. 183 cases of ground glass nodules, accounting for 14.08% of the total number; There were 4 cases of partial solid nodules, accounting for 0.31% of the total. According to the detection results of diameter, 228 cases of nodules were 10-30mm, accounting for 17.54% of the total number. 204 cases of pulmonary nodules, accounting for 15.69%; 137 pulmonary nodules were detected, accounting for 10.54% of the total number of patients. According to the number of pulmonary nodules, 547 cases were single nodules, accounting for 42.08% of the total. There were 22 cases of multiple nodules (1.70%). Univariate analysis showed that gender, age, BMI, family history of pulmonary cancer, pulmonary tuberculosis, emphysema, pneumonia, COPD, diabetes, air pollution, lampblack exposure, radiation exposure, dust exposure, chemical exposure, smoking, passive smoking, consumption of vegetables and fruits were the influencing factors for pulmonary nodules. Binary Logistic regression analysis showed that

age, family history of lung cancer, pulmonary tuberculosis, COPD, diabetes, air pollution, history of lampblack exposure, radiation exposure, dust exposure, chemical exposure, smoking, passive smoking, consumption of vegetables and fruits were the risk factors for pulmonary nodules. The regression equation = $2.444 +0.021X_2 +0.583X_4 +1.185X_5 +2.228X_8 +0.915X_9 +0.666X_{10} +0.471X_{11} +0.871X_{12} +0.574X_{13} +0.803X_{14} +1.082X_{15} +0.519X_{16} -00.611X_{17} -0.468X_{18}$. The prevalence of pulmonary nodules was high in Jinzhou city. The detection results of the number, density and diameter of pulmonary nodules showed that the detection rate of single nodules, solid nodules and 10-30mm nodules was the highest. Age, family history of lung cancer, tuberculosis, COPD, diabetes, history of lampblack exposure, air pollution, radiation exposure, dust exposure, chemical exposure, smoking and passive smoking are the risk factors for pulmonary nodules. Consumption of fruits and vegetables above 500g is a protective factor of pulmonary nodules, which can delay the occurrence and development of pulmonary nodules.

Keywords: Jinzhou City, in-service employees, pulmonary nodules, prevalence influence factor

Investigation and analysis of influencing factors of Pulmonary Nodules in Jinzhou City

1. Introduction

Pulmonary cancer is the leading cause of cancer deaths worldwide, and its prevalence ranks first among all malignant tumors. According to the World Health Organization, there are approximately 2.5 million new cases of pulmonary cancer worldwide in 2022, accounting for 11.4% of all malignant tumor cases and 18.0% of cancer-related deaths. According to cancer statistics in China, the incidence rate of pulmonary cancer ranks first at 35.92/100000, and it is also the main cause of cancer death. A study has pointed out that Pulmonary cancer is the largest confirmed cancer in North America and the main cause of cancer-related deaths among patients in Canada and the United States. According to the World Health Organization (WHO), it is predicted that by 2025, China will have over one million new pulmonary cancer deaths annually, making it the world's leading country in pulmonary cancer. The early clinical symptoms of pulmonary cancer lack typicality, and as the condition progresses, it will cause symptoms such as cough, sputum production, chest pain, and shortness of breath, increasing the difficulty of diagnosis and treatment. The preferred examination method for pulmonary cancer is lung CT, and pulmonary cancer can appear as pulmonary nodules on pulmonary CT. Therefore, research on pulmonary nodules is beneficial for the early detection of pulmonary cancer. As an early sign of pulmonary cancer, pulmonary nodules have no specific symptoms and will not have a significant impact on the structure and function of lung tissue. Early intervention in pulmonary nodules to prevent their deterioration can help reduce the incidence of pulmonary cancer.

Pulmonary nodule is a systemic granulomatous disease with unclear etiology and pathogenesis. It refers to a single, well-defined, opaque lesion with a diameter of ≤ 30mm completely surrounded by lung tissue in the pulmonary, without hilar or mediastinal lymph node enlargement, atelectasis, and pleural effusion. Pulmonary nodules are classified according to the number of nodules, with a single lesion referred to as solitary and two or more lesions referred to as multiple. According to the classification of nodule size, clinically, nodules with a diameter of 5-10mm are called small nodules, and nodules below 5mm are called small nodules. About 6% to 28% of pulmonary nodules are malignant tumors, and about 33% to 60% of pulmonary nodules are malignant tumors. It can be seen that as the nodule increases, the probability of malignancy also increases. According to the classification of nodule density, it can be divided into solid nodules, partially solid nodules, and ground glass nodules. The probability of malignancy, in descending order, is partial solid nodules, ground glass nodules, and solid nodules. According to the 2021 low-dose spiral CT (LDCT) screening guidelines in China, positive results are defined as: solid or partially solid nodules ≥ 5mm, non-solid nodules (pure ground glass density nodules) ≥ 8mm.In recent years, with the improvement of people's awareness of physical examinations and the popularization of CT, more and more asymptomatic pulmonary nodules have been detected.

Numerous pieces of evidence suggest that pulmonary cancer screening can improve the prognosis and quality of life of patients. In 1993, Cornell University in the United States led the International Early Pulmonary Cancer Action Plan. Subsequently, in 2002, the National Cancer Institute of the United States launched the National Pulmonary Cancer Screening Trial, which randomly assigned high-risk subjects to low-dose computed tomography (LDCT) and chest X-ray groups. After 6.5 years of follow-up, the mortality rate decreased by 6.7%. In 2011, the United States was the first to release pulmonary cancer screening guidelines, which clearly identified chest LDCT as the preferred lung cancer screening method. The research results of the National Cancer Institute in the United States indicate that LDCT screening in high-risk populations can reduce the mortality rate of pulmonary cancer by 20%, and screening a large number of asymptomatic pulmonary nodule patients can even reduce the overall mortality rate caused by any reason by 7%.In 2012, the 17th National Comprehensive Cancer Network Annual Conference in the United States focused on pulmonary nodule screening as the conference theme, providing suggestions for addressing issues related to LDCT screening. In

2017, the American Thoracic Association reached a consensus on the use of molecular testing for pulmonary nodule screening, adopting a dual screen (CT combined with molecular) detection technology route. According to the analysis of the 6-year follow-up data of the national screening trial, 18% of the screened cancers were false-positive. The screening standards should be raised and resolved through repeated Lectin China, a consensus among pulmonary cancer screening experts was released in 2015 to include LDCT as a commonly used screening method; In 2023, the latest revised Chinese pulmonary cancer screening guidelines still recommend this test as the preferred method for pulmonary cancer screening. This indicates that LDCT is increasingly recognized and applied as a pulmonary cancer screening tool at international and domestic levels.

The pulmonary cancer screening guidelines provide detailed recommendations for populations of different ages and risks. From a global perspective, the latest pulmonary cancer screening standards are similar. USPSTF recommends still using two key risk factors modeling, smoking history and age, for pulmonary cancer screening: adults aged 50-80, with a 20-year smoking history, currently smoking or quitting smoking within the past 15 years are the target population for pulmonary cancer screening and should undergo annual screening; Once there are bio-psychological issues that may seriously affect life expectancy or result in curative lung surgery, screening should be stopped. The National Comprehensive Network of the United States recommends screening high-risk individuals aged 50 and above with a smoking history of over 20 years. It should be pointed out that most pulmonary cancer risk prediction models are currently developed and validated in Western countries, There is some controversy over the applicability of this model among the Chinese population, and directly adopting its screening criteria may not be appropriate, as the characteristics and environmental factors of the Chinese population may differ from those of Western countries. The Chinese Low dose CT Screening Guidelines for Pulmonary Cancer (2023 Edition) target individuals aged 50-80, with a smoking history of ≥ 20 years or passive smoking for ≥ 20 years, smoking cessation for no more than 5 years, and long-term exposure to pulmonary cancer carcinogens such as radon, arsenic, beryllium, chromium and its compounds, asbestos, chloromethyl ether, silicon dioxide, coke oven emissions, and coal smoke. It emphasizes the combination of screening and smoking cessation to more comprehensively and accurately assess and intervene in lung cancer risk. The Clinical Diagnosis and Treatment Guidelines for Pulmonary Cancer of the Chinese Medical Association (2023 Edition) recommend that individuals over 45 years old should determine screening strategies based on multiple factors such as smoking and exposure to second-hand smoke. The Chinese Integrated Diagnosis and Treatment Guidelines for Cancer recommend screening for individuals aged 50-74 with a family history and high-risk factors for pulmonary cancer.

According to the analysis of the 6-year follow-up data of the national screening trial, 18% of the screened cancers were false-positive. The screening standards should be raised and resolved through repeated Lector country's national conditions are different from other developed countries, so our pulmonary nodule screening strategy cannot follow the foreign model. We should establish a precise pulmonary nodule screening path that is suitable for our population. The 13th Five Year Plan for Health and Health proposes to strengthen public health and major disease prevention and control, and promote the health of the whole population. West China Hospital of Sichuan University has established a full management model for healthy people's physical examination of pulmonary nodules. Online, the Internet model is used to provide remote guidance and management for patients, and offline, the outpatient model is used to communicate with patients face to face. A dedicated follow-up position has also been established to ensure the efficiency of follow-up. Some regions have started the combination of imaging technology and artificial intelligence technology to accurately evaluate pulmonary nodules and improve the detection efficiency of malignant pulmonary nodules. According to the Chinese Expert Consensus on Pulmonary Cancer Screening and Management (2023 Edition), both chest CT and LDCT can display the internal structure and edge features of pulmonary nodules. However, the advantage of LDCT is that it can reduce radiation damage to the pulmonary, so LDCT is chosen as an important means of pulmonary nodule screening. Since 2009, China has launched a rural pulmonary cancer screening project, which has achieved significant results in early screening of pulmonary cancer. Therefore, based on this project, China's pulmonary nodule screening guidelines have been developed.

LDCT has been widely promoted and applied in monitoring pulmonary nodules, and relevant departments have also provided health education to employees. Due to the outbreak of COVID-19 in 2020, pulmonary CT, as one of the criteria for diagnosing COVID-19, and the improvement of people's awareness of physical examination in recent years, most of the pulmonary nodules were accidentally found, so emphasizing the importance of regular physical examination, actively treating lung diseases, and early monitoring of pulmonary nodules can significantly reduce the prevalence rate. As a chronic comprehensive disease, pulmonary nodules are influenced by various factors, and the incidence of pulmonary nodules varies in different regions. The detection rate of pulmonary nodules varies depending on the occupation, age, smoking status, and other factors of the included population. The detection rate of pulmonary nodules in Hebei Province is 31.2%, Chongqing City is 16.3%, Beijing City is 18.5%, Changchun City is 51.3%, Urumqi is 41.7%, and Dalian City is 15.9%.

At present, there is no survey and analysis on the situation of pulmonary nodules in a large population in Jinzhou City. The aim of this study is to investigate the current situation and influencing factors of pulmonary nodules, in order to provide objective data for the prevention and screening of pulmonary nodules in the Jinzhou area, and to provide theoretical basis for relevant functional departments to carry out corresponding health guidance, prevention and control, and health management work.

Objectives of the Study - This study aimed to assess Jinzhou city enterprise or business unit on-the-job worker pulmonary nodules disease status and related influencing factors to investigate, analyze its risk factors, early evaluation of pulmonary nodules, in order to achieve early screening and discovery early intervention, targeted for health education and health guidance, change the lifestyle, improve the quality of life, and to achieve the effect of disease prevention.

2. Methods

Research Design - This research study utilized quantitative research method and descriptive method. Convenient sampling was used to select faculty and staff members of Bohai University, tax bureau staff, hospital staff, local petrochemical company staff, and public security bureau staff who underwent physical examinations at the Health Management Center of the First Affiliated Hospital of Jinzhou Medical University from October 2023 to May 2024. The working environment for employees at Bohai University and the tax bureau is relatively simple, while employees at hospitals, petrochemical companies, and public security bureaus are prone to occupational exposure. The inclusion criteria for study participants are between the ages of 20 and 60, with a certain level of understanding and cognitive ability, voluntarily completing all research procedures and following the research process, and being able to sign an informed consent form. The LDCT test results are opaque lesions with a diameter of ≤ 3cm completely wrapped by pulmonary tissue, no hilar or mediastinal lymph node enlargement, atelectasis, and pleural effusion. The criteria for exclusion were as follows: individuals with a history of pulmonary cancer surgery and evidence indicating the presence of other diseases that are not suitable for LDCT examination, individuals with abnormal conditions such as coughing, hemoptysis, and weight loss, pregnant women, lactating women, Pregnant women with incomplete information were mistakenly included in the study, individuals who did not fully participate in the study, withdrew from the study midway, and received psychological therapy before and during the study (self-description). Estimate the sample size based on the population rate, using $n=(Z\ \alpha/2/\delta)\ 2 * \pi\ (1- \pi)$, $Z\alpha/2 =Z0.05/2 =1.96$, The error does not exceed 3%, $\delta=0.03$. According to literature review, the detection rate of pulmonary nodules is 31.2%. Therefore, in this study, π is taken as 31.2%. After calculation, the sample size is about 907 cases, and considering a sampling error of 30%, $907 \div 0.7=1295$. It is expected to select 1350 people for this study.

Research Investigation - General information survey form: gender, age, height, weight, body mass index, educational level, marital status, personal monthly income, place of residence, and drinking history. The height (m) and weight (kg) of the participants were measured by an ultrasonic automatic height and weight measuring instrument, with a body mass index (BMI)=body mass (kg)/height $(m)^2$. Pulmonary nodule risk assessment questionnaire: A pulmonary nodule risk assessment questionnaire designed and written by the Air Force Military

Medical University includes family history of tumors, past medical history, exposure to oil fumes, occupational exposure history, dietary status, smoking status, and passive smoking status. The risk assessment indicators for pulmonary nodules include 7 dimensions and 20 questions. The variables included in the pulmonary nodule risk assessment model are all from the standardized basic questionnaire for common chronic disease risk assessment, and have high surface validity. The sampling suitability value (KMO) of the risk assessment model is around 0.6, and the common factors generated can explain that the contribution rate of the overall variance is greater than 50%. The structural validity and content validity are both good. The internal consistency Cronbach's a coefficient of this risk assessment model is 0.635, and the split half reliability Spearman Brown coefficient is 0.643.

Instruments of the Study - LDCT examination: 128 slice low-dose spiral CT is used to perform whole pulmonary plain scan on the subject, which has the characteristics of fast scanning speed, large examination range, high resolution, and reduced radiation dose. CT examination is performed by a radiologist. Before the examination, instruct the examinee to remove metal accessories and guide breath holding training. For those who discover pulmonary lesions, use multi plane reconstruction technology for image processing. Record the inspection results in detail and have them verified by two people.

Quantitative Analysis - Diagnostic grouping: The LDCT diagnostic results are classified according to the Chinese Expert Consensus on the Diagnosis and Treatment of Pulmonary Nodules (2023 Edition):According to quantity classification, a single lesion is isolated, and 2 or more lesions are multiple. According to the classification of lesion diameter, those with a diameter less than 5mm are defined as small nodules; A diameter of 5-10mm is defined as a small nodule. According to density classification, solid pulmonary nodules refer to circular or quasi circular high-density shadows in the lungs, with lesion density sufficient to mask the vascular and bronchial shadows that run through them; Ground glass nodules refer to pulmonary nodules with clear or unclear boundaries displayed on CT, but the density of the lesion is not sufficient to conceal the vascular and bronchial shadows that run through them. Mixed nodules, also known as partially solid nodules, are nodules with both ground glass density and solid density.

Variable definition: 1. Body Mass Index (BMI) classification: According to the Chinese Guidelines for the Prevention and Control of Overweight and Obesity in Adults, BMI<18.5kg/m2 is considered low weight, 18.5kg/m2 ≤ BMI<24.0 kg/m2 is considered normal, 24.0 kg/m2 ≤ BMI<28.0 kg/m2 is considered overweight, and ≥ 28.0 kg/m2 is considered obese. 2. Family history of tumors: Refers to one or more immediate relatives, including parents, grandparents, and maternal grandparents, who have cancer. 3. History of chronic lung disease: Refers to a diagnosis of pneumonia, emphysema, chronic bronchitis, COPD, tuberculosis, or pulmonary fibrosis by a second-class or higher medical institution. 4. Diagnostic criteria for hypertension: systolic blood pressure ≥ 140mmHg, and/or diastolic blood pressure ≥ 90mmHg, or having taken anti-hypertensive drugs within the past two weeks. 5. Diagnostic criteria for diabetes: refers to the fasting blood glucose (FBG) measured at random twice in a row ≥ 7mmol/L, and/or the fasting blood glucose FBG ≥ 11.1mmol/L 2 hours after two consecutive oral glucose tolerance tests, and/or self-reported being diagnosed as Type 2 diabetes (T2D) or undergoing T2D treatment. 6. Diagnostic criteria for heart disease: Diagnosed as a heart disease by a second class or higher medical institution. 7. Smoking situation: Smoking includes cigarettes and e-cigarettes. According to the WHO's definition of smoking, smoking more than one cigarette per day, continuously or cumulatively smoking for more than 6 months in a lifetime, and quitting smoking refers to having smoked or stopped smoking for 1 year or more. Passive smoking: Inhaling smoke exhaled by surrounding smokers for one day or more in the past week. 8. Definition of alcohol consumption: Occasional drinking refers to the investigation of drinking 1-3 days a week; Regular drinking refers to drinking for at least 4 days per week. 9. Eating fruits and vegetables; Eating at least 500g per day is considered a regular intake, while consuming less than 500g per day is considered a low intake.10. Air pollution: Industrial waste gas, domestic coal combustion, automobile exhaust, etc. caused by industrial production and transportation. 11. Exposure history to oil fumes: Inhaling harmful gases from oil fumes during cooking. 12. Occupational exposure history; In the working environment, there is exposure to high temperature, low temperature, radiation, dust, and chemical harmful substances.

Data Gathering Procedures - Perform statistical analysis after data collection is completed, the input, organization, and analysis of data shall be carried out using SPSS 23.0 software, and counting data shall be expressed in terms of examples and composition ratios, the difference test was analyzed using the chi square test, and the multivariate analysis was performed using binary logistic regression analysis. A $P<0.05$ value indicates statistical significance of the difference.

Qualitative Analysis - Quality control: Before the survey: consult a large amount of literature, select a questionnaire with good reliability and validity based on the research content, and conduct a preliminary survey based on the actual situation before the formal survey begins, to improve the survey tools. In the survey: All questionnaires were collected by the researcher themselves, using a one-on-one survey method. Before distributing the questionnaires, the researcher communicated with the research subjects, explained the survey purpose, and conducted the survey after gaining understanding. The research subjects fill out the survey questionnaire on the spot, and provide explanations and guidance for the questions and options in the questionnaire to avoid objectivity and personal bias. Each questionnaire should be controlled within 15 minutes, and the questionnaire should be collected and checked for completion by a dedicated person on the spot. Questionnaires with a completion rate of less than 85% will be excluded. After the survey: The results of the survey questionnaire were filled out using a dual person and dual machine input method to ensure the accuracy of the input information, and were promptly entered after the daily survey.

Ethical Considerations - For the sake of ethical considerations，before starting the study, fully communicate with eligible research subjects, explain the purpose, methods, significance, and research content of this study, and voluntarily participate after fully understanding. If the research subject is unable to continue participating for any reason or requests to terminate this study midway, consent will be given. During the research process, all information and privacy related to the research subject collected will be strictly confidential, and all data will only be used for this study and shall not be disclosed to anyone to ensure the confidentiality of the data. This survey was always conducted under the supervision of medical staff to ensure that all choices were made seriously and truthfully. All participants have completed informed consent forms, and this study has been approved by the Ethics Committee of the First Affiliated Hospital of Jinzhou Medical University.

3. Results and discussion

Table 1 shows the general demographic data of the participants in this study. A total of 1350 questionnaires were distributed and collected in this study, with a response rate of 100%. Excluding questionnaires that did not meet the standards, 1300 participants were ultimately included in the study, with an effective response rate of 96.29%.The total number of subjects in this study is 1300, including 569 patients with pulmonary nodules, with a prevalence rate of 43.77%. 698 males, accounting for 52.15%, and 622 females, accounting for 47.85%. The minimum age is 22 years old and the maximum is 60 years old, with an average age of (39.99 ± 9.78). Among them, the majority are between 31 and 40 years old, with a total of 482 people (37.08%); The number of people with a BMI within the normal range is the highest, with a total of 627 people (48.23%); The majority of undergraduate students have a higher education level, with a total of 702 people (54.00%); The highest number of married individuals were 1008 (77.54%); The maximum number of people with an economic income between 3000-5000 per month is 512 (39.38%); There are 1243 people (95.62%) residing in urban areas and 57 people (4.38%) residing in rural areas

Table 1
General Demographic Data Of Study Participants (n=1300)

Project	Group	No. of examples(n)	Composition ratio (%)
Sex	Male	678	52.15
	Female	622	47.85

Age	20~	248	19.08
	30~	482	37.08
	40~	345	26.53
	50~	225	17.31
BMI	Low body weight	50	3.85
Kg/m^2	Normal	627	48.23
	overweight	438	33.69
	Obesity	185	14.23
Education	Junior high school and below	22	1.69
	High school or vocational school	59	4.54
	junior college	209	16.08
	undergraduate	702	54.00
	Master's degree or above	308	23.69
Marriage	Unmarried	234	18.00
	Married	1008	77.54
	Divorce	58	4.46
Personal monthly income (RMB)	＜2000	11	0.85
	2000~	91	7.00
	3000~	512	39.38
	5000~	431	33.15
	＞8000~	255	19.62
Residence	City	1243	95.62
	Country	57	4.38

Table 2 shows the results of LDCT examination.Through LDCT examination, a total of 569 out of 1300 employees were found to have pulmonary nodules, accounting for 43.78% of the total number of examinations.

Table 2
The Results Of LDCT Examination

Project	Group	Number of examples(n)	Composition ratio (%)
Quantity.	Unilateral	547	42.08
	Multifocal	22	1.70
Density	Solidity	382	29.38
	Ground glass properties	183	14.08
	Partial solidity	4	0.31
Diameter	10~30mm	228	17.54
	Pulmonary nodules	204	15.69
	Pulmonary tiny nodules	137	10.54
Position	Left Pulmonary	251	19.31
	Right Pulmonary	181	13.92
	Bilateral Pulmonary	57	4.38

According to the number of nodule examinations, there were a total of 547 individuals with single nodules, accounting for 42.08% of the total number of examinations. There were also 22 individuals with multiple nodules, accounting for 1.70% of the total number of examinations. According to the classification of nodule density, there were 382 people with solid nodules, accounting for 29.38% of the total number of examines. There were 183 people (14.08%) with ground glass nodules, and 4 people (0.31%) with partial solid nodules. According to the classification of nodule diameter, 228 people with nodules ranging from 10 to 30mm were the majority, accounting for 17.54% of the total number of examinations. 204 people (15.69%) had pulmonary nodules, and 137 people (10.54%) had pulmonary nodules. According to the distribution of nodule locations, 251 people were mostly diagnosed with left pulmonary nodules, accounting for 19.31% of the total examination population. 181 people (13.92%) were diagnosed with right pulmonary nodules, and 57 people (4.38%) were diagnosed with bilateral pulmonary nodules.

Table 3 shows the comparison of different demographic data on the incidence of pulmonary nodules.The chi square test results showed that there were statistically significant differences in the impact of factors such as gender, age, and BMI on pulmonary nodules ($P<0.05$); However, there was no statistically significant difference in the impact of education level, marriage, personal monthly income, and place of residence on the development

of pulmonary nodules (P>0.05).

Table 3

The Comparison Of Different Demographic Data On The Incidence Of Pulmonary Nodules

Project	Group	Total no of people	No of sick individuals	χ^2	*P*
Sex	Male	678	350	24.882	<0.001
	Female	22	1.70		
Age	20~	248	69	46.941	<0.001
	30~	482	208		
	40~	345	160		
	50~	225	132		
BMI	Low body weight	50	17	12.914	0.005
	Normal	627	249		
	overweight	438	208		
	Obesity	185	95		
Education	unior high school and below	22	8	5.474	0.242
	High school or vocational school	59	27		
	junior college	209	104		
	undergraduate	702	307		
	Master's degree or above	308	123		
Marriage	Unmarried	234	63	2.146	0.342
	Married	1008	470		
	Divorce	58	36		
Personal monthly income (RMB	＜2000	11	5	8.552	0.073
	2000~	91	36		
	3000~	512	202		
	5000~	431	203		
	＞8000~	255	123		
Residence	City	1243	540	1.224	0.278
	Country	57	29		

Table 4

The Comparison Of The Incidence Of Pulmonary Nodules With Different Family Histories Of Tumors

Project	Group	Total no of people	No of sick individuals	χ^2	*P*
Pulmonary cancer	Have	162	98	21.032	＜0.001
Family history	None	1138	471		
Other tumors	Have	123	59	0.973	0.340
Other tumors	None	1177	510		

Table 4 shows a comparison of the incidence of pulmonary nodules with different family histories of tumors. According to the grouping based on the family history of pulmonary cancer, there were a total of 98 cases of pulmonary nodules in the group with a family history of pulmonary cancer, with a prevalence rate of 60.49%. In the group without a family history of pulmonary cancer, there were 471 patients with pulmonary nodules, with a prevalence rate of 41.39%, and the difference was statistically significant (P<0.001). According to grouping based on family history of other tumors, there were a total of 59 cases of pulmonary nodules in the group with a family history of other tumors, with a prevalence rate of 47.97%. In the group without a family history of pulmonary cancer, there were 510 cases of pulmonary nodules, with a prevalence rate of 43.33%, and the difference was not statistically significant (P>0.05).

Table 5 shows the comparison of the incidence of pulmonary nodules with different respiratory disease histories.The chi square test results showed that there was a statistically significant difference (P<0.05) in the occurrence of pulmonary nodules among patients with chronic pulmonary disease history, including tuberculosis, emphysema, pneumonia, and COPD. However, there was no statistically significant difference in the impact of pulmonary fibrosis on the formation of pulmonary nodules (P>0.05).

Table 5
The Comparison Of The Incidence Of Pulmonary Nodules With Different Respiratory Disease Histories

Respiratory system diseases	Group	Total no of people	No of sick individuals	χ^2	*P*
Pulmonary tuberculosis	Have	25	19	10.759	0.002
	None	1275	550		
Emphysema	Have	26	18	6.988	0.009
	None	1274	551		
Pneumonia	Have	70	40	5.376	0.025
	None	1230	529		
COPD	Have	14	13	13.856	＜0.001
	None	1286	556		
Pulmonary fibrosis	Have	17	10	1.586	0.227
	None	1283	559		

Table 6
The Comparison Of The Incidence Of Pulmonary Nodules With Different Histories Of Other Diseases

History of Other Diseases	Group	Total no of people	No of sick individuals	χ^2	*P*
Hypertension	Have	212	105	3.414	0.069
	None	1088	464		
Diabetes	Have	39	27	10.591	0.002
	None	1261	542		
Heart disease	Have	25	14	1.549	0.228
	None	1275	555		

Table 6 shows a comparison of the incidence of pulmonary nodules with different histories of other diseases. Chi square test showed that diabetes had a statistically significant effect on the generation of pulmonary nodules (P<0.05). However, there was no statistically significant difference in the occurrence of pulmonary nodules between hypertension and heart disease (P>0.05).

Table 7
The Comparison Of The Incidence Of Pulmonary Nodules With Different Environmental Exposure Histories

Environmental exposure history	Group	Total no of people	No of sick individuals	χ^2	*P*
air pollution	Have	99	63	17.186	＜0.001
	None	1201	506		
History of oil fume exposure	Have	985	461	15.192	＜0.001
	None	315	108		

Table 7 shows a comparison of the incidence of pulmonary nodules between different environmental exposure histories. The chi square test results showed that there were statistically significant differences (P<0.001) in the influence of air pollution and a history of oil fume exposure on the development of pulmonary nodules.

Table 8
The Comparison Of The Incidence Of Pulmonary Nodules With Different Occupational Exposure Histories

Occupational exposure history	Group	Total no of people	No of sick individuals	χ^2	*P*
high temperature	Have	27	17	4.127	0.050
	None	1273	552		
low temperature	Have	15	6	0.088	0.801
	None	1285	563		
radiation	Have	121	75	17.984	＜0.001
	None	1179	494		
dust	Have	127	77	16.258	＜0.001
	None	1173	492		
chemical substances	Have	148	91	21.301	＜0.001
	None	1152	478		

Table 8 Comparison of the incidence of pulmonary nodules among different occupational exposure histories. According to occupational exposure history grouping, it was found that there were statistically significant differences (P<0.05) in the production of pulmonary nodules affected by radiation, dust, and chemicals.

Table 9

The Comparison Of The Incidence Of Pulmonary Nodules Among Different Lifestyles

Occupational exposure history	Group	Total no of people	No of sick individuals	χ^2	*P*
smoke	Never smoke	963	359	63.574	<0.001
	Stopped smoking	157	98		
	smoke	180	112		
passive smoking	Have	797	386	18.193	<0.001
	None	503	183		
drink wine	never	437	181	3.775	0.151
	occasionally	669	310		
	often	194	79		
Fruit consumption/day	≤500g	1094	494	27.180	<0.001
	>500g	206	78		
Vegetable consumption/day	≤500g	929	426	23.771	<0.001
	>500g	371	143		

Table 9 shows the comparison of different lifestyles on the incidence of pulmonary nodules. The chi square test results showed that smoking, passive smoking, consuming fruits and vegetables had a statistically significant difference in the production of pulmonary nodules (P<0.001). However, there was no statistically significant difference (P>0.05) in the impact of alcohol consumption on the development of pulmonary nodules.

Table 10

The Assignment Of Influencing Factors In Logistic Regression Analysis

Variable	**index**	**Variable assignment**
X_1	Gender	Male=1, Female=2
X_2	Age	20~30=1，31~40=2, 41~50=3，51~60=4
X_3	BMI	Low weight=1, normal=2, overweight=3, obesity=4
X_4	Family history of pulmonary cancer	None=0, Yes=1
X_5	Pulmonary tuberculosis	None=0, Yes=1
X_6	Emphysema	None=0, Yes=1
X_7	Pneumonia	None=0, Yes=1

X_8	COPD	None=0, Yes=1
X_9	Diabetes	None=0, Yes=1
X_{10}	air pollution	None=0, Yes=1
X_{11}	Oil fume pollution	None=0, Yes=1
X_{12}	Radiation exposure	None=0, Yes=1
X_{13}	Dust exposure	None=0, Yes=1
X_{14}	Exposure to chemical substances	None=0, Yes=1
X_{15}	Smoking situation	Never smoking=1, quit smoking=2, smoking=3
X_{16}	passive smoking	None=0, Yes=1
X_{17}	Fruit consumption/day	500g below=1500g above=2
X_{18}	Vegetable consumption / day	500g below=1500g above=2

Tables 10 and 11 show the multivariate logistic analysis of the influencing factors of pulmonary nodules.The variables with statistically significant differences in the univariate analysis (see Table 10 for assignment) were included in the multivariate logistic regression analysis. The results showed that age, family history of pulmonary cancer, tuberculosis, COPD, diabetes, oil smoke exposure history, air pollution, radiation, dust, chemicals, smoking, and passive smoking were the risk factors for pulmonary nodules ($P<0.05$). Eating vegetables and fruits is a protective factor ($P<0.05$). See Table 11. Its logistic equation $Y=-2.444+ 0.021X_2 +0.583X_4 +1.185X_5 +2.228X_8 +0.915X_9 +0.666X_{10} + 0.471X_{11} +0.871X_{12} +0.574X_{13} +0.803X_{14} +1.082X_{15} +0.519X_{16} -00.611X_{17} -0.468X_{18}$.

A survey found that the incidence of pulmonary nodules in Jinzhou area is slightly higher than previous studies in other regions, which may be related to the previous detection method being chest X-ray and the current

detection method being LDCT.The survey results of the location, density, diameter, and quantity of pulmonary nodules in the study subjects showed that the highest incidence was found in the presence of nodules, solid nodules, 10-30mm pulmonary nodules, and single nodules in both lungs of the subjects.

Table 11
Logistic Regression Analysis Of Factors Influencing Pulmonary Nodules

Project	β	Standard error	χ^2	*P*	OR	95% confidence interval
Age	0.021	0.007	8.858	0.003	1.022	1.007~1.036
Family history of pulmonary cancer	0.583	0.195	8.932	0.003	1.792	1.222~2.627
Pulmonary tuberculosis	1.185	0.497	5.675	0.017	3.270	1.234~8.666
COPD	2.228	1.087	4.202	0.040	9.284	1.103~78.172
Diabetes	0.915	0.385	5.647	0.017	2.496	1.174~5.308
History of oil fume exposure	0.471	0.152	9.593	0.002	1.602	1.189~2.158
Air pollution	0.666	0.243	7.523	0.006	1.947	1.209~3.133
Radiation	0.871	0.214	16.519	<0.001	2.389	1.570~3.635
Dust	0.574	0.215	7.145	0.008	1.775	1.165~2.704
Chemical substances	0.803	0.199	16.367	<0.001	2.232	1.513~3.294
Eating 500g or more of fruits	-0.611	0.195	9.794	0.002	0.543	0..370~0.796
Eating 500g or more of vegetables	-0.468	0.150	9.173	0.002	0.626	0.466~0.840
Stopped smoking	0.644	0.219	8.655	0.003	1.904	1.240~2.923
smoke	1.082	0.213	25.821	<0.001	2.950	1.943~4.476
passive smoking	0.519	0.132	15.266	<0.001	1.680	1.297~2.177
constant	-2.444	0.497	24.145	<0.001	0.087	

The risk of pulmonary nodules is closely related to different ages. In this study, the lowest incidence rate of pulmonary nodules was 27.82% in the age group of 20-30 years old, and the highest incidence rate was 58.67% in the age group of 51-60 years old. This research result is consistent with the research data of foreign scholars McWilliams (2013)As age increases, the incidence of pulmonary nodules shows an upward trend. This study's logistic regression analysis suggests that age is a risk factor for the occurrence of pulmonary nodules (OR>1, P<0.001). The research results of the Mayo model and Peking University model both showed that age can be an independent risk factor for the malignancy of pulmonary nodules, and it was included in the prediction model. As age increases, the repair ability of cells gradually decreases, and under the stimulation of various carcinogenic factors, the incidence of pulmonary nodules continues to increase. Among them, ground glass nodules often occur between the ages of 51 and 60, while solid nodules often occur between the ages of 31 and 40; 20-30 years old is the age group at which pulmonary nodules are more common, and 31-40 years old is the age group at which pulmonary nodules are more common. At present, the trend of younger patients with pulmonary nodules is obvious. Therefore, for employees in the age groups of 21-30 and 31-40, regular publicity and education on knowledge related to pulmonary nodules should be carried out, and the importance of regular screening should be emphasized.

The risk of pulmonary nodules is closely related to a family history of pulmonary cancer. In this study, the incidence of pulmonary nodules was 60.49% in patients with a family history of pulmonary cancer, and 41.39% in patients without a family history of pulmonary cancer. In multivariate logistic regression analysis, there was a positive correlation between a family history of pulmonary cancer and the incidence of pulmonary nodules (OR=1.792, P<0.05). Li (2011) model believes that a family history of pulmonary cancer is an important factor in determining whether pulmonary nodules are benign or malignant. The results of the Danish pulmonary cancer screening trial show that a family history of pulmonary cancer is a significant predictive variable for the malignancy of pulmonary nodules. The Association for Genetic Epidemiology of Pulmonary Cancer suggests that chromosome 6 may contain numerous genes associated with pulmonary cancer. The genetic susceptibility of pulmonary cancer is closely related to peptides or defects in metabolic enzyme genes and DNA repair enzyme genes. Bailey Wilson believe that the presence of susceptibility genes, especially in first-degree relatives with a history of pulmonary cancer, increases the risk of developing pulmonary cancer.

The risk of pulmonary nodules is closely related to past respiratory diseases. This study included basic pulmonary diseases including pneumonia, emphysema, pulmonary fibrosis, chronic obstructive pulmonary

disease (COPD), and pulmonary tuberculosis. Multivariate results showed that a history of pulmonary tuberculosis and COPD increased the risk of developing pulmonary nodules (OR>1), P<0.05). In this study, the incidence of pulmonary nodules in individuals with COPD was more than 9 times higher than in the normal population's causes changes in the microenvironment of the pulmonary and bronchi due to airway inflammation, increasing the risk of gene mutations and epithelial mesenchymal transition. The International Pulmonary Cancer Collaborative Group found that tuberculosis can increase the incidence of pulmonary cancer by 1.48 times in 2012. In this study, the incidence of pulmonary nodules was more than three times higher than that of the normal population, based on the presence of pulmonary tuberculosis. The mechanism of pulmonary tuberculosis developing pulmonary nodules may be related to macrophages, chronic inflammation, immunosuppression, and calcification pulling pulmonary tissue. The occurrence of pulmonary nodules is associated with a history of underlying pulmonary diseases, but their nature often suggests benign and may be related to lesions in certain substances in the pulmonary, affecting the normal function and status of cells and promoting the production of pulmonary nodules. Drug management should be given to patients with respiratory diseases. COPD patients can use glucocorticoids, which directly affect genes in the cell nucleus, causing corresponding changes in RNA expression and inhibiting the synthesis of inflammatory factors. Long term home oxygen therapy can also be implemented to improve blood gas levels, improve lung ventilation, and have a positive effect on the prevention and treatment of complications. Patients with pulmonary tuberculosis are given standard chemotherapy regimens and undergo regular follow-up to prevent the occurrence of complications such as pulmonary nodules.

The risk of pulmonary nodules is closely related to certain chemical and physical factors. The subjects of this study are employees of petrochemical companies who come into direct contact with chemical and radioactive substances in their work environment. Hospital employees are more susceptible to radiation exposure, while public security bureau employees are more susceptible to exposure to air pollution. The International Agency for Research on Cancer has shown that 12 occupational exposure factors, including aluminum, arsenic, asbestos, coke, and gas, have carcinogenic effects on human pulmonary. In this survey, high temperature, low temperature, radiation, dust, and chemicals were included in the study, and the results showed that radiation, dust, and chemicals are risk factors for the development of pulmonary nodules. Most employees of petrochemical companies live near the factory area, and long-term exposure to dust and inhalation of chemical gases can reduce the self-purification ability of the respiratory system, making it difficult for the body to effectively expel particulate matter and allowing particulate matter to deposit and develop into nodules in the lungs. The emitted chemicals contain a large amount of toxic gases such as benzene, chlorine, ammonia, methane, ethylene, and organic compounds, which stimulate the respiratory mucosa and pulmonary, increasing the risk of pulmonary nodules. This study found that the incidence of pulmonary nodules in individuals with a history of radiation exposure is more than twice that of the normal population. Prolonged exposure to radiation can cause extensive cell death, leading to damage to human organs and systems, and causing various diseases. A certain dose of radiation can cause damage to alveolar type II epithelial cells, leading to a decrease in their secretion of alveolar surfactant, decreased pulmonary compliance, alveolar collapse, and the formation of radiation-induced pulmonary fibrosis, which can easily deposit into pulmonary nodules.

The risk of pulmonary nodules is closely related to smoking. In this study, the prevalence of smoking was 62.22%, the prevalence of smoking cessation was 62.42%, and the prevalence of non-smoking was 37.28%. According to the grouping based on whether there is a history of passive smoking, the incidence of pulmonary nodules in the group with a history of passive smoking was 48.43%, while the incidence of pulmonary nodules in the group without passive smoking was 36.38%. Binary logistic regression analysis suggests that smoking and passive smoking increase the risk of pulmonary nodules. Studies by Gómez-Sáez (2018) and others have shown that smokers and former smokers have a higher risk of developing pulmonary cancer in patients with pulmonary nodules compared to non-smokers. The risk of pulmonary cancer in males who smoke is 4.97 times higher than that of non-smokers, in a dose-response relationship. The risk of pulmonary cancer among smoking women is 19 times higher than that of non-smoking women, and the relative risk of pulmonary cancer among women with severe smoking is 12.81 times higher than that of men with the same smoking index. Traditional tobacco

contains over 3000 substances, including 30 carcinogens. Nicotine exposure increases addiction to cocaine, alcohol, and other substances, and an increase in dosage concentration can lead to poisoning. Inhalation of smoke stimulates the nose, throat, trachea, bronchi, and lungs, resulting in toxic effects that cause mucosal congestion, increased secretion, and acute inflammation of the pulmonary. Hartmann (2018) applied nicotine replacement therapy (NRT) as a clinical smoking cessation drug in their clinical trials. Compared with not taking any measures, the use of NRT can increase the success rate of smoking cessation by more than twice. Compared with traditional cigarettes, NRT is less addictive, and the concentration of nicotine in the blood is reduced, with higher safety, which has been recognized by WHO. Experimental studies by Qiu (2015) have shown that adding tea extract as antioxidant to cigarette filters can reduce the damage caused by nicotine and tar.

Electronic cigarettes have rapidly emerged among young people since their launch, and research data shows that the usage rate of electronic cigarettes in various countries is showing an increasing trend year by year. Compared with traditional cigarettes, electronic cigarettes contain harmful substances and smoke in their liquid, aerosols, and seasonings, which also damage human pulmonary function. Farsalinos (2015) and Mikheev (2016) used gas chromatography-mass spectrometry to experimentally determine that electronic cigarette leaf liquid contains tobacco specific nitrosamines, carbonyl compounds produced by aerosol heating in electronic cigarettes, and free radicals released by seasoning agents in electronic cigarettes after heating, It has cytotoxicity, reduces cell viability, causes a large number of deaths of human pulmonary fibroblasts, pulmonary epithelial cells, and human embryonic stem cells, leading to pulmonary inflammation and tissue organ damage, promoting the growth of pulmonary nodules.

Passive smoking (also known as second-hand smoke, environmental smoking, and unintentional smoking) refers to people living and working around smokers unconsciously inhaling smoke, which damages Passive smoking (also known as second-hand smoke, environmental smoking, and unintentional smoking) refers to people living and working around smokers unconsciously inhaling smoke, which damages pulmonary function. Zhao (2010) pointed out that passive smoking is an important risk factor for pulmonary cancer in the non-smoking population in China. The research results of foreign scholars show that the risk coefficient of passive smokers is 1.14 to 5.20 times higher than that of non-passive smokers. The US pulmonary cancer screening expert group did not consider secondhand smoke exposure to be an independent risk factor for pulmonary cancer in 2012. The main cause of female pulmonary nodules is passive smoking in the family environment, while the main cause of non-smoking male pulmonary nodules is passive smoking in the work environment.

Cigarette smoke contains the strong carcinogen benzo pyrene, and long-term exposure can easily cause mutations in the cancer suppressor gene P53, which has the most direct genotoxic effect, promoting the proliferation, migration, and invasion of tumor cells, and increasing the risk of asthma and COPD. function. Zhao (2010) pointed out that passive smoking is an important risk factor for pulmonary cancer in the non-smoking population in China. The research results of foreign scholars show that the risk coefficient of passive smokers is 1.14 to 5.20 times higher than that of non-passive smokers. The US pulmonary cancer screening expert group did not consider secondhand smoke exposure to be an independent risk factor for pulmonary cancer in 2012. The main cause of female pulmonary nodules is passive smoking in the family environment, while the main cause of non-smoking male pulmonary nodules is passive smoking in the work environment.

The risk of pulmonary nodules is closely related to an unreasonable dietary structure. In this study, it was found that the incidence of pulmonary nodules was 44.66% among those who consumed less than 500g of vegetables per day, 38.54% among those who consumed more than 500g of vegetables per day, 42.21% among those who consumed less than 500g of fruits per day, and 37.86% among those who consumed more than 500g of fruits per day. The results of multiple factors show that consuming more vegetables and fruits is a protective factor for the disease of pulmonary nodules. Vegetables and fruits contain abundant phytochemicals, such as isothiocyanates, indoles, flavonoids, etc. Which can regulate anti-tumor related pathways, inhibit tumor cell

proliferation, and induce tumor cell apoptosis. Its anti-tumor mechanism is that vegetables and fruits contain a large amount of vitamin C, E, and various bioactive compounds. Vitamin C and E, as antioxidants, can inhibit the occurrence of tumors, inhibit the oxidation of unsaturated fatty acids, promote DNA damage repair, and bioactive compounds play a protective role in human cells. The disease of pulmonary nodules is closely related to cooking fumes. Oil fume produces various carcinogens, such as aldehydes, heterocyclic amines, polycyclic aromatic hydrocarbons, fatty aerosols, and particulate matter. Exposure to oil fume increases oxidative stress and endoplasmic reticulum stress, affecting cell survival ability, causing DNA damage and cellular oxidative damage, and inducing apoptosis of alveolar epithelial cells. The generated condensate has cytotoxic effects on human embryonic pulmonary diploid cells and affects macrophage function. In households, the use of range hoods can be extended. It is recommended to steam, cook, and stew food, and try to minimize frying, frying, or frying of food, reducing the amount of cooking oil used, and thus reducing the generation of oil fume pollutants.

4. Conclusions and recommendations

The incidence rate of pulmonary nodules among in-service employees in Jinzhou City is relatively high at 43.77%, with the highest incidence rate occurring in the age group of 50-60 years old. All units should strengthen the popularization of health knowledge among employees in this age group. Among the 300 LDCT results, solid nodules were the main type of nodule density classification. Therefore, it is necessary to strengthen the tracking and follow-up of this population and intervene in a timely manner. Age, family history of pulmonary cancer, tuberculosis, COPD, diabetes, oil smoke exposure history, air pollution, radiation, dust, chemicals, smoking, passive smoking are the high-risk factors for pulmonary nodules. Eating over 500g of vegetables and fruits daily is a protective factor for pulmonary nodules. Healthy dietary habits enhanced physical exercise, and a lifestyle that corrects unhealthy behaviors can prevent and delay the occurrence and development of pulmonary nodules.

The incidence of pulmonary nodules among in-service employees in enterprises and institutions in Jinzhou City is relatively high. Units should pay attention to the health examinations of employees, increase the number of examinations appropriately, and carry out health knowledge promotion and education for employees according to their own situation. Telephone follow-up should be conducted for individuals with abnormal physical examination results, and tracking management should be strengthened. A follow-up system for suspicious cases should be implemented to improve their compliance with relevant examinations. Early detection of pulmonary diseases, timely treatment, and psychological counseling should be provided to avoid panic and anxiety. Relevant health departments and enterprises should strengthen the popularization of knowledge related to pulmonary nodules and the benefits of pulmonary nodule screening, attach importance to early screening, early detection, and early intervention of pulmonary nodules, to prevent their deterioration and progression to pulmonary cancer lesions. In summary, there are many influencing factors for pulmonary nodules among in-service employees in enterprises and institutions in Jinzhou City. It is necessary to increase physical exercise, develop healthy lifestyle habits, eat more than 500g of vegetables and fruits every day, enhance occupational exposure protection, and treat diseases such as tuberculosis and COPD, thereby reducing the incidence of pulmonary nodules in the local area.

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