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Level of knowledge on low-dose CT lung cancer screening in Sichuan province, China: a cross-sectional study

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ABSTRACT

Objectives Low-dose CT (LDCT) can help determine the early stage of lung cancer and reduce mortality. However, knowledge of lung cancer and lung cancer screening among community residents and medical workers, and potential factors that may affect medical institutions to set up LDCT are limited.

Design A cross-sectional study was conducted in Sichuan province, China, in 2021. Community residents, medical workers and medical institutions were randomly selected, and participants responded to related questionnaires. Knowledge of lung cancer and LDCT lung cancer screening was evaluated. Data analyses were performed using SAS V9.4.

Results A total of 35,692 residents, 6,350 medical workers and 81 medical institutions were recruited; 4.05% of the residents were very familiar with lung cancer and 37.89% were (completely) unfamiliar. Characteristics, such as age and level of education, were significantly related to residents who were very familiar with lung cancer. Furthermore, 22.87% of the residents knew that LDCT can effectively screen for early-stage lung cancer, which was correlated with smoking (OR 1.1300; 95% CI 1.0540 to 1.2110; p=0.006) and family history of cancer (OR 1.2210; 95% CI 1.1400 to 1.3080; p<0.0001); 66.06% of medical workers believed that LDCT can detect early-stage lung cancer. Technicians and nurses were less knowledgeable than doctors about whether LDCT can effectively screen for early-stage lung cancer (OR 0.6976; 95% CI 0.5399 to 0.9015; p=0.0059 and OR 0.6907; 95% CI 0.5718 to 0.8496; p=0.0004, respectively). Setting up LDCT in medical institutions was related to grade, administrative rank, number of hospital beds that opened and total number of medical workers.

Conclusions The knowledge of lung cancer in residents is relatively low, and the knowledge of LDCT in screening (early-stage) lung cancer needs to be improved both in residents and medical workers. Possible factors that affect medical institutions to set up LDCT may need to be incorporated.

INTRODUCTION

Lung cancer ranks first among malignant tumours worldwide, a serious threat to people’s health and life expectancy. It is estimated that 1.8 million people died from lung cancer in 2018 worldwide, accounting for almost 20% of cancer-related deaths. With the development of ageing and unhealthy lifestyle, the cancer spectrum of China and its incidence have changed, and the burden of lung cancer has increased rapidly in recent years. Lung cancer is the leading cause of cancer-related death and is a main public health problem in China. The average cost per patient with lung cancer increased from ¥40 508 to ¥66 020 in the period 2005–2014. Because of a lack of relevant clinical symptoms in the early stages, most patients with lung cancer are diagnosed as stage III or stage IV. Effective lung cancer screening for patients to determine lung cancer at an early stage is important, which will help to early diagnose and treat the patients, leading to reduction of lung cancer mortality, improved prognosis of the patients with lung cancer and alleviated social-economic burden.

Sputum cytology (SC) and chest X-ray are widely accepted and are commonly used to detect and diagnose lung cancer. However, some studies showed that chest X-ray screening and SC had no benefit in reducing lung cancer mortality. Currently, the most promising method for early detection of lung cancer is low-dose CT (LDCT). The findings of the National Cancer Institute’s National Lung Screening Trial reported that the use of LDCT compared with chest X-ray for lung cancer screening can reduce mortality by 20%.
hospital-based retrospective cohort study revealed that LDCT screening for lung cancer helped reduce the 5-year mortality from 83.54% to 69.44% from 2008 to 2017. After lung cancer screening using LDCT, the detection rate of lung cancer was increased, and the proportion of patients with stage IV was decreased. The US Preventive Services Task Force recommended annual lung screening with LDCT for a high-risk population. Participation in the lung cancer screening programme for the high-risk population with lung cancer is associated with the knowledge of lung cancer prevention and control. However, to date, little is known about the LDCT screening for lung cancer in the Chinese population. In this study, we first conducted a questionnaire survey among the population of Sichuan province, China, including community residents, medical workers and medical institutions, to understand their knowledge about lung cancer screening and potential factors that may affect LDCT set-up. The results of this study will show us the real status of the knowledge of residents and medical workers on (LDCT) lung cancer screening. What should the government do? How does the government, especially medical workers and medical institutions, improve the relatively low level of knowledge about LDCT screening for lung cancer in residents?

MATERIALS AND METHODS

Study design

The present study was conducted in Sichuan province (including community residents, medical workers and medical institutions) to study if participants know CT, especially LDCT, can screen for (early-stage) lung cancer, and we evaluated possible factors that may affect setting up LDCT in medical institutions. There are 21 municipalities in Sichuan province. Due to the limited population in Ganzi Prefecture and Aba Prefecture, participants were randomly selected from the other 19 municipalities according to the total number of residents, medical workers and medical institutions. The information on the number of residents, medical workers and medical institutions was from the Sichuan Provincial Health Statistical Yearbook 2020. Among the 19 municipalities, Panzhihua municipality and Liangshan Prefecture were located on the Yunnan Guizhou Plateau, and the other 17 municipalities were located in Sichuan Basin. Therefore, we first divided the 17 municipalities into four districts: the eastern, southern, western and northern districts of Sichuan province. We randomly selected municipalities, counties and communities from the above districts, and then we selected residents, medical workers and medical institutions, evaluating knowledge on LDCT screening for early-stage lung cancer. Similarly, the counties and communities of Panzhihua municipality and Liangshan Prefecture were selected, and residents, medical workers and medical institutions were also selected (figure 1).

Participants and questionnaire

This study includes questionnaires for community residents, medical workers and medical institutions; the medical workers were selected from medical institutions. A total of 37 571 residents, 6478 medical workers and 81 medical institutions were surveyed. A total of 42 123 questionnaires were qualified for analysis, including 35 692 from residents (95.00%), 6350 from medical workers (98.02%) and 81 from medical institutions (100.00%). There were 20 data points in the residents’ questionnaire, mainly including age, sex, ethnicity, education level, type of medical insurance, average income/person/month, smoking or not, years of smoking, family history of cancer and whether the residents did a physical examination, knowledge of lung cancer, especially the payment, and the main reason for selecting CT (LDCT) for lung cancer screening (table 1).

There were 23 data points in the medical workers’ questionnaire, information that includes sex, ethnicity, education level, professional title, post, department,
**Table 1** Characteristics of the residents

| Characteristic | Number (%)/mean±SD |
|---------------|--------------------|
| Age (years)   | 42.0±14.2          |
| Sex           |                    |
| Male          | 18 610 (52.14)     |
| Female        | 17 082 (47.86)     |
| Nation        |                    |
| Chinese Han   | 34 676 (97.15)     |
| Chinese Bai   | 16 (0.04)          |
| Chinese Tibetan | 305 (0.85)    |
| Chinese Hui   | 131 (0.37)         |
| Chinese Manchu| 57 (0.16)          |
| Chinese Miao  | 31 (0.09)          |
| Chinese Yi    | 248 (0.69)         |
| Others        | 228 (0.64)         |
| Education level |                |
| Master or above | 3897 (10.92)    |
| University/college | 20 497 (57.43) |
| Senior school, professional high school, special school or below | 11 298 (31.65) |
| Type of medical insurance | |
| Basic medical insurance for urban and rural residents | 10 355 (29.01) |
| Basic medical insurance for urban workers | 19 845 (55.60) |
| Commercial insurance | 762 (2.13)      |
| New rural cooperative medical system | 3975 (11.13) |
| None | 755 (2.12) |
| Average income/person/month (within the last year) | |
| ¥>5000 | 15 734 (44.08) |
| ¥4001~¥5000 | 6812 (19.09) |
| ¥3001~¥4000 | 6598 (18.49) |
| ¥2001~¥3000 | 4167 (11.67) |
| ¥≤2000 | 2381 (6.67) |
| Smoke | |
| Yes | 9734 (27.27) |
| No | 25 958 (72.73) |
| Years of smoking | 18.7±12.0 |
| Average number of cigarettes/day | |
| <20 | 6756 (69.41) |
| ≥20 | 2978 (30.59) |
| Family history of cancer | |
| Yes | 6013 (16.85) |
| No | 29 679 (83.15) |
| Physical examination | |
| 1 time/year | 22 230 (62.28) |
| Once irregularly | 9157 (25.66) |
| None | 4305 (12.06) |
| Content of the physical examination | |
| Chest CT or low-dose spiral CT | 17 531 (49.12) |
| Chest X-ray | 11 536 (32.32) |
| None | 6625 (18.56) |
| Knowledge of lung cancer | |
| Very familiar | 1444 (4.05) |
| Quite familiar | 6530 (18.30) |
| Generally familiar | 14 197 (39.78) |
| Unfamiliar | 11 170 (31.30) |
| Completely unfamiliar | 2351 (6.59) |
| Do you know low-dose spiral CT can effectively screen for early-stage lung cancer? | |
| Yes | 8162 (22.87) |
| No | 27 530 (77.13) |
years of working in medicine and health, and whether the medical workers know methods to screen for (early-stage) lung cancer, treatment for early-stage lung cancer, how to follow up patients with lung nodules, especially the reasons to recommend LDCT screening for early-stage lung cancer (table 2).

In the medical institutions’ questionnaire, there were 38 data points, mainly including grade, administrative rank, nature, number of hospital beds that actually opened, number of doctors, whether medical institutions perform a physical examination, whether the physical examination set up CT/carry out (LDCT) lung cancer screening, and whether medical institutions joined the medical alliance for pulmonic nodules/lung cancer, especially if medical institutions recommend cases detecting pulmonic nodules to other hospitals for treatment (tables 3 and 4).

The inclusion criteria for the participants were as follows: (1) aged >18 years; (2) participants can understand questions in Chinese and answer all questions. All participants answered all the questions. These questionnaires were used for the first time in this study, which were carefully designed according to the suggestion of a pilot study from residents, medical workers and medical institutions. Reliability and validity were >0.800 (Cronbach’s α value for reliability and Kaiser-Meyer-Olkin value for validity).

**Data management**

Epidata V.3.1 was used to establish the database and double-input verification was used to confirm data consistency. After data input, the data were checked. If there were issues with the questionnaires, the original questionnaires were returned to the investigators for a check, and participants re-answered the questionnaires. Finally, the investigators returned all qualified questionnaires, and the data administrator revised and confirmed the data.

**Patient and public involvement**

Patients or the public were not involved in designing, conducting, reporting or disseminating this research.

**Statistical analysis**

We used SAS V.9.4 for statistical analysis. Quantitative data were described as mean±SD if they were normally distributed; otherwise, they were described as median (interquartile). Qualitative data were described as the proportion

| Characteristic                                                                 | Number (%)/mean±SD |
|-------------------------------------------------------------------------------|--------------------|
| Which channel do you know low-dose spiral CT can effectively screen for early-stage lung cancer? |                    |
| Family, friends or colleagues                                                 | 1199 (14.69)       |
| Media (internet, TV, newspapers, magazines, brochures)                       | 3490 (42.76)       |
| Medical workers                                                               | 3473 (42.55)       |
| Have you screened for lung cancer by chest CT before?                         |                    |
| Yes                                                                           | 11 256 (31.54)     |
| No                                                                            | 14 929 (41.82)     |
| Don’t remember                                                                | 9507 (26.64)       |
| How much will you pay for low-dose chest spiral CT?                           |                    |
| ¥>500                                                                         | 4312 (12.08)       |
| ¥401~¥500                                                                    | 3327 (9.32)        |
| ¥301~¥400                                                                    | 5628 (15.77)       |
| ¥201~¥300                                                                    | 10 161 (28.47)     |
| ¥100~¥200                                                                    | 7718 (21.62)       |
| ¥<100                                                                        | 4546 (12.73)       |
| What is the main reason for screening for lung cancer?                         |                    |
| Routine physical examination                                                  | 18 564 (52.02)     |
| Family members or friends had a history of lung cancer or other tumours      | 5045 (14.13)       |
| Doctor’s advice                                                              | 9037 (25.32)       |
| Current smoking or smoking before                                            | 3046 (8.53)        |
| Which institution do you think is more suitable for CT screening?             |                    |
| Health examination institution                                                | 7825 (21.92)       |
| Provincial hospital                                                           | 8948 (25.07)       |
| Municipal hospital                                                            | 9394 (26.32)       |
| County-level hospital                                                         | 5718 (16.02)       |
| Community health centre                                                       | 3807 (10.67)       |
| Do you feel anxious if pulmonic nodules are detected during your physical examination? |                |
| Very anxious                                                                 | 4671 (13.09)       |
| A little anxious                                                              | 20 394 (57.14)     |
| Not anxious                                                                  | 10 627 (29.77)     |
| Characteristic | Number | Proportion (%) |
|---------------|--------|----------------|
| **Sex**       |        |                |
| Male          | 1528   | 24.06          |
| Female        | 4822   | 75.94          |
| **Nation**    |        |                |
| Chinese Han   | 6234   | 98.17          |
| Chinese Bai   | 2      | 0.03           |
| Chinese Tibetan | 29   | 0.46           |
| Chinese Hui   | 15     | 0.24           |
| Chinese Manchu | 5    | 0.08           |
| Chinese Miao  | 4      | 0.06           |
| Chinese Yi    | 34     | 0.54           |
| Others        | 27     | 0.43           |
| **Education level** |   |            |
| Doctor of Philosophy | 53  | 0.83          |
| Master        | 502    | 7.91           |
| Undergraduate | 3720   | 58.58          |
| College       | 1860   | 29.29          |
| Senior school, professional high school, special school | 215 | 3.39 |
| **Professional title** |   |            |
| Senior        | 120    | 1.89           |
| Associate     | 664    | 10.46          |
| Middle        | 2128   | 33.51          |
| Primary       | 3436   | 54.11          |
| None          | 2      | 0.03           |
| **Post**      |        |                |
| Nurse         | 3294   | 51.87          |
| Technician    | 608    | 9.57           |
| Public administration | 248 | 3.91 |
| Doctor        | 2200   | 34.65          |
| **Department** |        |                |
| Respiratory medicine | 984 | 15.50 |
| Health management centre | 845 | 13.31 |
| General practice | 792 | 12.47 |
| Thoracic surgery | 556 | 8.76 |
| Others        | 2388   | 37.61          |
| Oncology      | 785    | 12.36          |
| **Years working for medicine and health** |   |            |
| ≥15           | 1514   | 23.84          |
| 10–14         | 1341   | 21.12          |
| 5–9           | 1811   | 28.52          |
| <5            | 1684   | 26.52          |
| How much do you know about the dangers of lung cancer? |   |            |
| Very familiar | 1636   | 25.76          |
| Quite familiar | 2646 | 41.67 |
| Generally familiar | 1776 | 27.97 |
| Unfamiliar    | 265    | 4.17           |
| Completely unfamiliar | 27 | 0.43 |
| How much do you know about lung cancer diagnosis? |   |            |
| Very familiar | 1231   | 19.39          |
| Quite familiar | 2479 | 39.04 |
| Generally familiar | 2091 | 32.93 |
| Unfamiliar    | 495    | 7.80           |
| Completely unfamiliar | 54 | 0.85 |

Continued
Table 2  Continued

| Characteristic                                                                 | Number | Proportion (%) |
|-------------------------------------------------------------------------------|--------|----------------|
| How much do you know about lung cancer screening guidelines?                   |        |                |
| Very familiar                                                                 | 1009   | 15.89          |
| Quite familiar                                                                | 2173   | 34.22          |
| Generally familiar                                                            | 2198   | 34.61          |
| Unfamiliar                                                                    | 879    | 13.84          |
| Completely unfamiliar                                                         | 91     | 1.43           |
| Which lung cancer screening method will you select according to high-risk population? |        |                |
| MRI                                                                           | 5      | 0.08           |
| Thin-slice CT                                                                 | 16     | 0.25           |
| Low-dose spiral CT                                                            | 2683   | 42.25          |
| General CT                                                                    | 2240   | 35.28          |
| Chest-enhanced CT                                                             | 18     | 0.28           |
| Chest X-ray                                                                   | 1372   | 21.61          |
| Unclear                                                                       | 16     | 0.25           |
| Which lung cancer screening method do you think is the most effective according to high-risk population? |        |                |
| Low-dose spiral CT                                                            | 3297   | 51.92          |
| Biopsy                                                                        | 6      | 0.09           |
| General CT                                                                    | 1127   | 17.75          |
| Sputum cell culture                                                           | 565    | 8.90           |
| Chest X-ray                                                                   | 636    | 10.02          |
| Bronchoscope                                                                   | 610    | 9.61           |
| Unclear                                                                       | 109    | 1.72           |
| Do you know the effect of treatment for early-stage lung cancer?              |        |                |
| Very familiar                                                                 | 1058   | 16.66          |
| Quite familiar                                                                | 2175   | 34.25          |
| Generally familiar                                                            | 2174   | 34.24          |
| Unfamiliar                                                                    | 865    | 13.62          |
| Completely unfamiliar                                                         | 78     | 1.23           |
| How much do you know about low-dose spiral CT screening for lung cancer?     |        |                |
| Very familiar                                                                 | 781    | 12.30          |
| Quite familiar                                                                | 1660   | 26.14          |
| Generally familiar                                                            | 2090   | 32.91          |
| Unfamiliar                                                                    | 1587   | 24.99          |
| Completely unfamiliar                                                         | 232    | 3.65           |
| Do you think low-dose spiral CT screening can detect early-stage lung cancer? |        |                |
| Yes                                                                           | 4195   | 66.06          |
| No                                                                            | 182    | 2.87           |
| Unclear                                                                       | 1973   | 31.07          |
| Does your medical institution provide low-dose spiral CT screening?           |        |                |
| Yes                                                                           | 3074   | 48.41          |
| No                                                                            | 1436   | 22.61          |
| Unclear                                                                       | 1840   | 28.98          |
| Do you know the limitation and potential risk of low-dose spiral CT screening for lung cancer? |        |                |
| Yes                                                                           | 2841   | 44.74          |
| No                                                                            | 3299   | 51.95          |
| Unclear                                                                       | 210    | 3.31           |
| Do you know how to follow up the patients with lung nodules who have been detected by low-dose spiral CT screening? |        |                |
| Yes                                                                           | 3254   | 51.24          |
| No                                                                            | 3096   | 48.76          |

Continued
A two-sample t-test was used to analyse quantitative data, and a $X^2$ test was used for categorical data. The R×C contingency data were compared using the R×C $X^2$ test. Dependent ordinal data were analysed using the Kruskal-Wallis H test, and the normal approximation U test was used to analyse the differences between different groups. The logistic stepwise regression test or generalised estimating equation of the Genmod program (OR, 95% CI) analysed potential factors related to knowledge of lung cancer screening. As multiple tests were performed on different models, covariates were controlled. The level of significance was set at $p<0.05$ (two sided).

RESULTS
Cognition of community residents on lung cancer screening

Characteristics of residents

Of the 35 692 community residents, 18 610 (52.14%) were male and 17 082 (47.86%) were women. Most of the residents were of Chinese Han origin (97.15%). The average age of the residents was 42.0±14.2 years. Regarding education level, 10.92% of the residents had a master’s degree or higher, 57.43% graduated from universities/colleges, and 31.65% attended senior school, professional high school, special school, or below. For the types of medical insurance, 29.01% of the residents had basic medical insurance for urban and rural residents, 55.60% had basic medical insurance for urban workers, 2.13% had commercial insurance, 11.13% had a new rural cooperative medical system and 2.12% of the residents had no medical insurance. Other characteristics include average income/person/month (within the last year), smoking, years of smoking, average number of cigarettes/day, family history of cancer, physical examination, contents of the physical examination, knowledge of lung cancer, and knowledge of lung cancer screening (ie, ‘do you know LDCT can effectively screen for early-stage lung cancer?’ that channels to the following questions: ‘do you know LDCT can effectively screen for early-stage lung cancer?’; ‘have you been screened for lung cancer using chest CT before?’; ‘how much will you pay for LDCT?’; ‘what is the
main reason for lung cancer screening?'; 'which institution do you think is more suitable for CT screening?'; 'do you feel anxious if pulmonic nodules are detected during your physical examination?') are shown in table 1.

Potential factors related to residents’ knowledge of lung cancer

As shown in table 1, for the residents’ knowledge of lung cancer, 4.05% were very familiar with lung cancer, 18.30% were quite familiar, 39.78% were generally familiar, 31.30% were unfamiliar and 6.59% were completely unfamiliar. Univariate and multivariate analyses were performed gradually to discuss the possible reasons (table 5 and online supplemental tables 1 and 2).

The results showed that age (48.0±15.8 years), education level (master’s or higher and university/college), type of medical insurance (basic medical insurance for urban and rural residents), average income/person/month within the last year (¥>5000, ¥4001–¥5000, ¥3001–¥4000 and ¥2001–¥3000), smoking (yes), family history
of cancer (yes), physical examination (once irregularly, one time/year), and contents of the physical examination (chest X-ray, chest CT or LDCT) were significantly related to residents who were very familiar with lung cancer. For example, residents who had an average income/person/month (within the last year) of ¥>2000 were more familiar with lung cancer than residents who had an average income/person/month of ¥<2000. Similarly, residents with higher education level (ie, master’s degree or higher and university/college) were more familiar with lung cancer than those with lower education level (senior school, professional high school, special school or below).

Residents’ knowledge of whether LDCT can effectively screen for early-stage lung cancer

Being a potential and more precise method to detect early-stage lung cancer, LDCT has been gradually used in medical institutions. However, how much do residents know about LDCT in early-stage lung cancer screening? Reasons that may affect residents’ knowledge about LDCT in early-stage lung cancer need to be clarified.

Our results showed that 22.87% of residents knew that LDCT can effectively screen for early-stage lung cancer (table 1).

For example, residents who smoke and residents with a family history of cancer know that LDCT can effectively screen for early-stage lung cancer more than those who did not smoke or those families without a family history of cancer (OR 1.1300; 95% CI 1.0540 to 1.2110; p=0.006 and OR 1.2210; 95% CI 1.1400 to 1.3080; p<0.0001, respectively) (table 6 and online supplemental tables 3 and 4).

Medical workers’ knowledge of whether LDCT can effectively screen for early-stage lung cancer

Characteristics of medical workers

Of the 6350 medical workers from 81 medical institutions, 24.06% were male and 75.94% were female (table 2 and online supplemental table 5). Chinese Han was the main ethnicity (98.17%). Regarding education level, 0.83% had a Doctor of Philosophy, 7.91% had master’s degree, 58.58% were undergraduates, 29.29 had college degree, and 3.39% attended senior school, professional
Factors that can be correlated with medical workers’ knowledge about LDCT’s effectiveness to screen early-stage lung cancer

Approximately 66.06% of medical workers believed that LDCT could detect early-stage lung cancer, while 2.87% did not believe that LDCT can detect early-stage lung cancer. Approximately 31.07% of medical workers were unclear whether LDCT can detect early-stage lung cancer or not. An analysis was performed to investigate the reasons that may affect medical workers’ knowledge about LDCT to effectively screen early-stage lung cancer (table 7 and online supplemental tables 6 and 7).

In summary, technicians and nurses were less knowledgeable than doctors about LDCT’s effectiveness to screen for early-stage lung cancer. In summary, technicians and nurses were less knowledgeable than doctors about LDCT’s effectiveness to screen for early-stage lung cancer than medical workers in the oncology department (OR 0.6971; 95% CI 0.5718 to 0.8496; p=0.0004, respectively) (table 7). Medical workers in the thoracic surgery department were less knowledgeable about LDCT’s effectiveness to screen for early-stage lung cancer than medical workers in the medical institution who provided LDCT screening were more knowledgeable about LDCT’s effectiveness to screen early-stage lung cancer than the medical workers in the medical institution who did not provide LDCT screening (OR 3.2567; 95% CI 2.5867 to 4.1002; p<0.0001). Other results are summarised in table 7.

### Table 5  Multivariate analysis for residents’ knowledge about lung cancer

| Characteristic                                      | OR (95% CI)     | P value* |
|-----------------------------------------------------|-----------------|----------|
| Age (years)                                         | –               | 0.0126   |
| Sex                                                 | 0.9878 (0.9449 to 1.0328) | 0.5899   |
| Education level                                     |                 |          |
| Master or above (X3)                                | 1.4137 (1.3003 to 1.5370) | <0.0001  |
| University/college (X2)                              | 1.4697 (1.3893 to 1.5548) | <0.0001  |
| Type of medical insurance                            |                 |          |
| Basic medical insurance for urban and rural residents (X5) | 1.1972 (1.0371 to 1.3821) | 0.0140   |
| Basic medical insurance for urban workers (X4)       | 1.0805 (0.9354 to 1.2482) | 0.2925   |
| Commercial insurance (X3)                            | 0.9890 (0.8165 to 1.1980) | 0.9101   |
| New rural cooperative medical system (X2)            | 1.0860 (0.9324 to 1.2648) | 0.2889   |
| Average income/person/month (within the last year)   |                 |          |
| ¥>5000 (X5)                                         | 1.5242 (1.3851 to 1.6772) | <0.0001  |
| ¥4001~¥5000 (X4)                                    | 1.4045 (1.2736 to 1.5489) | <0.0001  |
| ¥3001~¥4000 (X3)                                    | 1.3991 (1.2718 to 1.5392) | <0.0001  |
| ¥2001~¥3000 (X2)                                    | 1.4179 (1.2849 to 1.5647) | <0.0001  |
| Smoke                                               |                 |          |
| Family history of cancer                             | 1.1643 (1.1074 to 1.2242) | <0.0001  |
| Physical examination                                 |                 |          |
| Once irregularly (X3)                                | 1.5225 (1.4137 to 1.6397) | <0.0001  |
| 1 time/year (X2)                                    | 1.9970 (1.8524 to 2.1529) | <0.0001  |
| Content of the physical examination                  |                 |          |
| Chest X-ray (X3)                                    | 1.6159 (1.5210 to 1.7166) | <0.0001  |
| Chest CT or low-dose spiral CT (X2)                  | 1.9498 (1.8372 to 2.0694) | <0.0001  |

*Dependent variables are polytomous ranked variables, and the generalised estimating equation of the Genmod program (SAS V.9.4) was used to analyse the data.

high school or special schools. Other characteristics are listed in table 2.
Characteristics of medical institutions and relation of LDCT set-up in medical institutions with influencing factors

Basic information about medical institutions

In this study, 81 medical institutions in Sichuan province were selected and investigated. Regarding the grade of the medical institutions, 4 medical institutions had grade II level A, 7 had grade II level B, 25 had grade III level A, 12 had grade III level B and 33 medical institutions did not have a grade (table 3). Nineteen medical institutions were municipal hospitals, 2 were independent physical examination institutions, 6 were provincial hospitals, 19 were county-level hospitals and 35 were community health centres. Regarding the nature of the medical institutions, 78 were governmental hospitals and 3 were private hospitals. Among all medical institutions, the average number of hospital beds actually opened was 171.00 (39.00 to 1061.00), and the number of medical workers was 215.00 (65.00 to 1074.00) (table 4). Other information on medical institutions is shown in tables 3 and 4.

Factors related to setting up LDCT in the physical examination centre of medical institutions

Setting up LDCT in the physical examination centre of a medical institution promotes a better screen for (early-stage) lung cancer. However, this may be correlated for several reasons. We compared possible factors that may affect setting up LDCT. The results showed that setting up LDCT was significantly related to the factors, including grade, administrative rank, the performing of a physical examination, and the questions of ‘does the physical examination centre set up CT?’, ‘does the physical examination centre perform a lung cancer screening?; ‘does the physical examination centre perform LDCT screening?’; ‘whether referral hospitals joined the medical alliance for pulmonic nodules/lung cancer’; ‘whether they trained medical workers according to the LDCT screening guidelines for lung cancer in China’; ‘whether they knew the number of patients with early-stage lung cancer, the number of hospital beds that actually opened, the total number of medical workers, the number of medical workers with the associate, senior professional titles, number of radiologists, etc’ (tables 8 and 9).

For example, regarding the index of performing a physical examination, there are more medical institutions setting up LDCT screening (34 of 63) than medical institutions that did not set up LDCT screening (2 of 18). Furthermore, in terms of the index referral hospital,
Table 7  Multivariate analysis of medical workers’ knowledge that low-dose spiral CT can effectively screen early-stage lung cancer

| Characteristic | OR (95% CI) | P value |
|---------------|------------|---------|
| Sex           | 0.8731 (0.7214 to 1.0566) | 0.1632  |
| Nation (after merging all non-Chinese Han) | 1.5131 (0.9583 to 2.3889) | 0.0755  |
| Education level (after merging Doctor of Philosophy and master, undergraduate and college) | | |
| Doctor of Philosophy and master (X3) | 1.2687 (0.7919 to 2.0326) | 0.3224  |
| Undergraduate and college (X2) | 1.0314 (0.7228 to 1.4719) | 0.8646  |
| Professional title (after merging senior and associate, primary and none) | | |
| Senior and associate (X3) | 1.2917 (0.9417 to 1.7717) | 0.1125  |
| Middle (X2) | 0.9109 (0.7639 to 1.0863) | 0.2989  |
| Post | | |
| Public administration (X4) | 1.0046 (0.6993 to 1.4432) | 0.9802  |
| Technician (X3) | 0.6976 (0.5399 to 0.9015) | 0.0059  |
| Nurse (X2) | 0.6970 (0.5718 to 0.8496) | 0.0004  |
| Department | | |
| Others (X6) | 0.8402 (0.6458 to 1.0930) | 0.1944  |
| Thoracic surgery (X5) | 0.6971 (0.4975 to 0.9766) | 0.0360  |
| General practice (X4) | 0.9008 (0.6562 to 1.2367) | 0.5182  |
| Health management centre (X3) | 1.3107 (0.9330 to 1.8413) | 0.1188  |
| Respiratory medicine (X2) | 0.9113 (0.6837 to 1.2146) | 0.5263  |
| Years working for medicine and health | | |
| ≥15 (X4) | 1.1032 (0.8611 to 1.4134) | 0.4373  |
| 10–14 (X3) | 1.2267 (0.9840 to 1.5291) | 0.0693  |
| 5–9 (X2) | 1.1800 (0.9807 to 1.4196) | 0.0795  |
| How much do you know about the dangers of lung cancer? | | |
| Very familiar (X5) | 1.3409 (0.4655 to 3.8626) | 0.5868  |
| Quite familiar (X4) | 1.1971 (0.4253 to 3.3697) | 0.7333  |
| Generally familiar (X3) | 1.0375 (0.3708 to 2.9024) | 0.9441  |
| Unfamiliar (X2) | 0.9024 (0.3207 to 2.5396) | 0.8458  |
| How much do you know about lung cancer diagnosis? | | |
| Very familiar (X5) | 2.3582 (0.9183 to 6.0562) | 0.0746  |
| Quite familiar (X4) | 1.3055 (0.5572 to 3.0589) | 0.5394  |
| Generally familiar (X3) | 1.4262 (0.6244 to 3.2577) | 0.3996  |
| Unfamiliar (X2) | 1.2301 (0.5355 to 2.7346) | 0.6114  |
| How much do you know about lung cancer screening guidelines? | | |
| Very familiar (X5) | 0.6333 (0.2793 to 1.4356) | 0.2739  |
| Quite familiar (X4) | 1.3560 (0.6891 to 2.6685) | 0.3779  |
| Generally familiar (X3) | 1.0796 (0.5659 to 2.0596) | 0.8161  |
| Unfamiliar (X2) | 1.2374 (0.6647 to 2.3035) | 0.5018  |
| Which lung cancer screening method will you select according to high-risk population? | | |
| Unclear (X7) | 1.4965 (0.4669 to 4.7966) | 0.4975  |
| Chest-enhanced CT (X6) | 0.6414 (0.2217 to 1.8557) | 0.4125  |
| General CT (X5) | 1.0210 (0.8474 to 1.2302) | 0.8267  |
| Low-dose spiral CT (X4) | 1.2507 (1.0268 to 1.5234) | 0.0263  |
| Thin-slice CT (X3) | 0.3725 (0.1036 to 1.2393) | 0.3779  |
| MRI (X2) | 1.1325 (0.1317 to 9.7382) | 0.9098  |
| Which lung cancer screening method do you think is the most effective according to high-risk population? | | |
| Unclear (X7) | 1.1893 (0.7353 to 1.9237) | 0.4798  |
| Chest X-ray (X6) | 1.0225 (0.7713 to 1.3554) | 0.8773  |
| Sputum cell culture (X5) | 1.1913 (0.9060 to 1.5664) | 0.2100  |
| General CT (X4) | 1.4058 (1.1069 to 1.7854) | 0.0052  |
| Biopsy (X3) | 0.3064 (0.0567 to 1.6557) | 0.1694  |
| Low-dose spiral CT (X2) | 3.7530 (3.0027 to 4.6906) | <0.0001 |
| Do you know the effect of treatment for early-stage lung cancer? | | |
| Very familiar (X5) | 2.7148 (1.2411 to 5.9384) | 0.0124  |
| Quite familiar (X4) | 1.5008 (0.7744 to 2.9085) | 0.2291  |
| Generally familiar (X3) | 1.2534 (0.6651 to 2.3621) | 0.4848  |
| Unfamiliar (X2) | 1.1946 (0.6475 to 2.2039) | 0.5693  |

Continued
medical institutions setting up LDCT screening will be more willing to recommend detected cases of pulmonic nodules to high-grade medical institutions, such as West China hospital (10 of 12).

**DISCUSSION**

This study is the first to discuss the screening for lung cancer with LDCT in community residents, medical workers and medical institutions in Sichuan province, China. The discussion of the emerging health problem (lung cancer) with a large, random sample covering all geographical areas and hospital grades is a unique strength of this study. The information obtained from this study could help government and public health campaigns target high-risk groups to conduct lung cancer screening.

Among community residents, knowledge about lung cancer was poor; 37.89% were (completely) unfamiliar with lung cancer, and only 22.87% of residents knew that LDCT can effectively screen for early-stage lung cancer. Studies found that those who were older, smokers and had a high level of education/income were more likely to know about lung cancer screening.11–13 This was partially similar to our findings. Our study showed that residents with basic medical insurance for urban and rural residents, had physical examination, had a family history of cancer, and had chest X-ray or LDCT were more knowledgeable about lung cancer. The reasons that may affect residents' knowledge of LDCT’s effectiveness to screen early-stage lung cancer were older age, smoking, having high education level/commercial insurance/family history of cancer/physical examination (one time/year), and knowing that LDCT can effectively screen for early-stage lung cancer. Residents familiar with lung cancer are better informed that LDCT can effectively screen early-stage lung cancer, and there is a significant progressive correlation between the two results. Regarding the factors that influence the awareness rate of the two results, sex is the unique influencing factor for residents’ awareness rate of LDCT screening for early-stage lung cancer, which may be related to more male

| Characteristic | OR (95% CI) | P value |
|---------------|-------------|---------|
| How much do you know about low-dose spiral CT screening for lung cancer? | | |
| Very familiar (X5) | 4.0945 (2.3668 to 7.3962) | <0.0001 |
| Quite familiar (X4) | 2.1904 (1.4654 to 3.2741) | 0.0001 |
| Generally familiar (X3) | 2.3933 (1.6869 to 3.3956) | <0.0001 |
| Unfamiliar (X2) | 1.3480 (0.9710 to 1.8714) | 0.0744 |
| Does your medical institution provide low-dose spiral CT screening? | | |
| Unclear (X3) | 0.4882 (0.4057 to 0.5874) | <0.0001 |
| Yes (X2) | 3.2567 (2.5867 to 4.1002) | <0.0001 |
| Do you know the limitation and potential risk of low-dose spiral CT screening for lung cancer? | | |
| Unclear (X3) | 1.1348 (0.7977 to 1.6144) | 0.4820 |
| Yes (X2) | 1.7385 (1.4011 to 2.1573) | <0.0001 |
| Do you know how to follow up the patients with lung nodules who have been detected by low-dose spiral CT screening? | | |
| Low-dose spiral CT screening for lung cancer is cost-effective (X4) | 0.4009 (0.2914 to 0.5515) | <0.0001 |
| Refer to the Chinese Lung Cancer Screening Guidelines (X3) | 0.7195 (0.6015 to 0.8606) | 0.0003 |
| Low-dose spiral CT screening can reduce lung cancer mortality (X2) | 0.5904 (0.4774 to 0.7301) | <0.0001 |
| Which is the main reason you recommend low-dose spiral CT screening? | | |
| No necessity for screening (X4) | 0.8297 (0.6689 to 1.0292) | 0.0894 |
| High proportion of false-positive results (X3) | 0.7710 (0.6429 to 0.9246) | 0.0050 |
| Exposure to radiation (X2) | 1.3080 (1.0776 to 1.5875) | 0.0066 |
| What is the main reason why you do not recommend low-dose spiral CT screening? | | |
| The technical level of medical technicians (X6) | 0.7723 (0.6324 to 0.9050) | 0.0116 |
| The level of awareness for medical workers (X5) | 0.6514 (0.4842 to 0.9214) | 0.0178 |
| Whether there is health insurance (X4) | 0.8687 (0.7272 to 1.2500) | 0.3365 |
| The level of awareness for residents (X3) | 0.8947 (0.6051 to 1.1450) | 0.3436 |
| Income (X2) | 0.8324 (0.6187 to 1.1500) | 0.1981 |
| What is the most important factor affecting low-dose spiral CT screening? | | |
| Where will you recommend the screened patients for treatment who had pulmonic nodules? | | |
| West China hospital (X5) | 3.6246 (2.0612 to 6.3736) | <0.0001 |
| Provincial hospital (X4) | 3.1476 (1.7910 to 5.5317) | <0.0001 |
| Municipal hospital (X3) | 3.5942 (2.0644 to 6.2578) | <0.0001 |
| County-level hospital (X2) | 2.0295 (1.1339 to 3.6325) | 0.0172 |
Table 8  Univariate analysis for medical institutions setting up low-dose spiral CT in the physical examination centre (categorical variables)

| Variable                                      | Does the physical examination centre set up low-dose spiral CT screening? | Total number | Statistic | P value |
|-----------------------------------------------|---------------------------------------------------------------------------|--------------|-----------|---------|
| Grade                                         |                                                                           |              |           |         |
| Grade II level A                              | Yes 1, No 3                                                             | 4            | –         | <0.0001* |
| Grade II level B                              | Yes 1, No 6                                                             | 7            |           |         |
| Grade III level A                             | Yes 21, No 4                                                            | 25           |           |         |
| Grade III level B                             | Yes 10, No 2                                                            | 12           |           |         |
| No grade                                      | Yes 3, No 30                                                           | 33           |           |         |
| Administrative rank                           |                                                                           |              |           |         |
| Municipal hospital                            | Yes 16, No 3                                                            | 19           | –         | <0.0001* |
| Independent physical examination institution  | Yes 2, No 0                                                             | 2            |           |         |
| Provincial hospital                           | Yes 6, No 0                                                             | 6            |           |         |
| County-level hospital                         | Yes 11, No 8                                                            | 19           |           |         |
| Community health centre                       | Yes 1, No 34                                                           | 35           |           |         |
| Nature                                        |                                                                           |              |           |         |
| Governmental hospital                         | Yes 33, No 45                                                          | 78           | –         | 0.0837* |
| Private hospital                              | Yes 3, No 0                                                             | 3            |           |         |
| Carrying out physical examination             |                                                                           |              |           |         |
| Yes                                           | Yes 34, No 29                                                          | 63           | 10.4143   | 0.0013† |
| No                                            | Yes 2, No 16                                                           | 18           |           |         |
| Does the physical examination centre set up CT? |                                                                           |              |           |         |
| Yes                                           | Yes 29, No 12                                                          | 41           | 23.2356   | <0.0001† |
| No                                            | Yes 7, No 33                                                           | 40           |           |         |
| Does the physical examination centre carry out lung cancer screening? |                                                                           |              |           |         |
| Yes                                           | Yes 35, No 7                                                           | 42           | 53.4288   | <0.0001† |
| No                                            | Yes 1, No 38                                                           | 39           |           |         |
| Does the physical examination centre carry out low-dose spiral CT screening? |                                                                           |              |           |         |
| Yes                                           | Yes 23, No 34                                                          | 57           | –         | 0.0033* |
| No                                            | Yes 13, No 5                                                            | 18           |           |         |
| Which department will be recommended after detecting pulmonic nodules in the physical examination centre? |                                                                           |              |           |         |
| Respiratory medicine                          | Yes 0, No 6                                                             | 6            | 7.1192    | 0.0076† |
| Thoracic surgery                              | Yes 15, No 32                                                          | 47           |           |         |
| Oncology                                      | Yes 21, No 13                                                          | 34           |           |         |
| Referral hospital                              |                                                                           |              |           |         |
| West China hospital                           | Yes 10, No 2                                                            | 12           | –         | <0.0001* |
| Hospital with grade III                       | Yes 5, No 29                                                           | 34           |           |         |
| Hospital with grade II                        | Yes 0, No 1                                                            | 1            |           |         |
| If joined in the medical alliance for pulmonic nodules/lung cancer                          |                                                                           |              |           |         |
| Yes                                           | Yes 20, No 3                                                            | 23           | 23.5106   | <0.0001† |
| No                                            | Yes 16, No 42                                                           | 58           |           |         |
| If trained for medical workers according to the guidelines of low-dose spiral CT screening for lung cancer in China |                                                                           |              |           |         |
| Yes                                           | Yes 27, No 4                                                            | 31           | 37.0013   | <0.0001† |
| No                                            | Yes 9, No 41                                                           | 50           |           |         |

Continued
smokers and may explain the difference in awareness rate. Furthermore, residents who had a chest CT/LDCT/X-ray for lung cancer screening before and those who accepted the doctor’s advice of lung cancer screening knew that LDCT can effectively screen early-stage lung cancer. A recent study showed that 80.6% of smokers would be interested in lung cancer screening and would accept LDCT if recommended by their doctors. Interestingly, 25.3% of smokers believed that doctor’s advice was the main reason for lung cancer screening, and 52.01% of smokers believed that routine physical examination was the reason for lung cancer screening. Therefore, to better increase residents’ awareness of lung cancer, especially the knowledge of LDCT in screening early-stage lung cancer, it is suggested that several actions may be necessary. First, provide lung cancer screening/prevention education to residents. Second, lung cancer screening/prevention education must be conducted in younger residents, as the incidence rate of lung cancer is gradually increasing in younger residents. Third, the government needs to increase residents’ education level and income, which may then encourage more residents to purchase medical insurance and do physical examinations.

A recent study published by Wu et al showed that smokers were less willing to participate in the LDCT screening programme (only 0.97% of patients with lung cancer were detected by screening in smokers). Wu et al recruited 2883 patients with lung cancer and assigned the patients into four groups according to smoking and screening status: not screened for lung cancer with LDCT+no history of smoking; screened for lung cancer with LDCT+no history of smoking; not screened for lung cancer with LDCT+a history of smoking; and screened for lung cancer with LDCT+a history of smoking. In their study, residents with a smoking history knew that LDCT can effectively screen for early-stage lung cancer (OR 1.1300; p=0.0006) (table 6). Several reasons may be correlated with the discrepancy. First, the participants were different (patients without lung cancer in our study). Our findings were consistent with several previous studies. Cataldo discussed the perceptions, attitudes and beliefs of high-risk older smokers with respect to lung cancer screening. More than 82% of the participants believed that a person who continued to smoke after the age of 40 years had at least a 25% chance of developing lung cancer, and 77.3% were willing to undergo an LDCT screening. They also believed that early detection of lung cancer using LDCT would lead to a good prognosis and were not afraid of CT scans. Sharma et al reported that 52% of current and former smokers were aware of lung cancer screening. Among participants who had not been screened before, 80.6% will take a lung cancer screening programme. Second, the sample size for statistical analysis may affect the result, by which Wu et al found that 0.97% of lung cancer were detected by screening in smokers (N=12). The number is relatively small and larger studies will be needed in the future. Third, the willingness to undergo LDCT screening for lung cancer may correlate with smokers’ attitudes and socioeconomic status. Wu et al believed that less willingness for LDCT screening programmes in their study may contribute to smokers’ negative attitudes and low socioeconomic status. On the mainland China, morbidity and mortality of lung cancer rank first among all malignant tumours, and there has been a close relationship between long-term smoking and lung cancer in recent years. Therefore, the Chinese government has done much to educate residents not to smoke. However, we believe that this action needs to continue and increase publicity.

The knowledge and attitude of medical workers about LDCT screening for lung cancer are important because they sometimes recommend residents to undergo lung cancer screening. Previous studies on medical workers’ perception of LDCT screening focused on lung cancer specialists and primary care providers. Almost all lung cancer specialists and physicians agreed that lung cancer screening is necessary; LDCT screening can increase the chance of early detection of lung cancer and the survival of patients. However, less than half of primary care providers were aware of LDCT screening, and many were sceptical of its effectiveness. In our study, medical workers were assigned to four groups: nurse (51.87%), doctor (34.65%), technician (9.57%) and administrator (3.91%). Most medical workers knew the lung cancer screening guidelines (84.73%) and the LDCT screening for lung cancer (71.36%), and they believed that LDCT can detect early-stage lung cancer. We found that different posts may affect medical worker’s knowledge about

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**Table 8 Continued**

| Variable                                         | If knew number of patients with early-stage lung cancer | Does the physical examination centre set up low-dose spiral CT screening? |
|--------------------------------------------------|--------------------------------------------------------|-------------------------------------------------------------------|
|                                                   | Very familiar                                          | Yes | No | Total number | Statistic | P value |
| If knew number of patients with early-stage lung cancer | Generally familiar                                   | 6   | 0  | 6            | -         | <0.0001* |
|                                                   | Unfamiliar                                             | 7   | 38 | 45           |           |         |

*Fisher’s exact test. **Fisher’s exact test.

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12 Cataldo et al. BMJ Open 2022;12:e061987. doi:10.1136/bmjopen-2022-061987
Table 9  Univariate analysis for medical institutions setting up low-dose spiral CT in the physical examination centre (quantitative variables)

| Variables | Median (P 25–P 75 ) | Statistic | P value |
|-----------|---------------------|-----------|---------|
| Number of inpatient beds actually opened | Yes | 1030.50 (750.00–1800.00) | 2060.0000 | <0.0001 |
| | No | 50.00 (24.00–150.00) |
| Total number of medical workers | Yes | 1037.00 (601.50–1693.50) | 2111.5000 | <0.0001 |
| | No | 68.00 (51.00–210.00) |
| Number of medical workers with associate, senior professional title | Yes | 159.00 (78.50–257.50) | 2052.5000 | <0.0001 |
| | No | 6.00 (2.00–23.00) |
| Number of radiologists | Yes | 18.50 (11.00–28.50) | 2126.0000 | <0.0001 |
| | No | 2.00 (0.00–3.00) |
| Number of medical technicians | Yes | 16.50 (10.00–36.00) | 2130.5000 | <0.0001 |
| | No | 1.00 (1.00–4.00) |
| Number of respiratory doctors | Yes | 11.50 (8.00–18.00) | 2039.5000 | <0.0001 |
| | No | 1.00 (0.00–6.00) |
| Number of thoracic surgery doctors | Yes | 8.00 (4.00–10.50) | 2041.5000 | <0.0001 |
| | No | 0.00 (0.00–0.00) |
| Number of physical examination doctors | Yes | 7.00 (5.00–10.00) | 1959.0000 | <0.0001 |
| | No | 2.00 (0.00–6.00) |
| Average number of participants who did physical examination/day, if physical examination is carried out | Yes | 103.00 (80.00–161.00) | 573.0000 | <0.0001 |
| | No | 25.00 (5.00–50.00) |
| Fee for physical examination/person (¥) | Yes | 1000.00 (603.87–1250.00) | 2148.0000 | <0.0001 |
| | No | 100.00 (0.00–200.00) |
| Number of participants from unit/number of individuals who did physical examination (%) | Yes | 5.00 (2.00–6.50) | 1937.0000 | <0.0001 |
| | No | 1.00 (0.00–3.00) |
| Average cost of participant from unit who did physical examination (¥) | Yes | 1200.00 (827.50–1500.00) | 2136.0000 | <0.0001 |
| | No | 75.00 (0.00–220.00) |
| Average cost of individual who did physical examination (¥) | Yes | 985.00 (625.00–1500.00) | 2116.0000 | <0.0001 |
| | No | 75.00 (0.00–200.00) |
| Number of CT | Yes | 2.00 (1.00–2.00) | 211.0000 | 0.2219 |
| | No | 1.00 (1.00–1.50) |
| Number of 16-slice spiral CT | Yes | 0.00 (0.00–1.00) | 292.0000 | 0.2009 |
| | No | 1.00 (0.00–1.00) |
| Number of 32-slice spiral CT | Yes | 0.00 (0.00–0.00) | 222.0000 | 0.1369 |
| | No | 0.00 (0.00–0.00) |
| Number of spiral CT with 64-slice or above | Yes | 1.00 (1.00–2.00) | 175.5000 | 0.0193 |
| | No | 1.00 (0.00–1.00) |
| Proportion of individuals who selected chest CT in the physical examination centre (%) | Yes | 5.00 (2.50–7.50) | 2069.0000 | <0.0001 |
| | No | 0.00 (0.00–0.00) |
| Number of individuals who selected chest CT/number of individuals who selected chest X-ray in the physical examination centre in year 2018 (%) | Yes | 3.00 (1.00–5.50) | 2072.0000 | <0.0001 |
| | No | 0.00 (0.00–0.00) |
| Number of individuals who selected chest CT/number of individuals who selected chest X-ray in the physical examination centre in year 2019 (%) | Yes | 4.00 (2.00–7.00) | 2031.0000 | <0.0001 |
| | No | 0.00 (0.00–1.00) |
| Number of individuals who selected chest CT/number of individuals who selected chest X-ray in the physical examination centre in year 2020 (%) | Yes | 4.50 (2.00–7.00) | 2124.0000 | <0.0001 |
| | No | 0.00 (0.00–0.00) |

Continued
LDCT’s effectiveness to screen early-stage lung cancer; for example, technicians (OR 0.6976; 95% CI 0.5399 to 0.9015) and nurses (OR 0.6970; 95% CI 0.5718 to 0.8496) were less knowledgeable than doctors about LDCT’s effectiveness to screen early-stage lung cancer. Furthermore, the responses of ‘very familiar’ to the question ‘do you know the effect of treatment for early-stage lung cancer?’; ‘very familiar, quite familiar, generally familiar’ to the question ‘how much do you know about LDCT in screening for lung cancer?’; ‘yes’ to the question ‘do you know the limitation and potential risk of LDCT screening for lung cancer?’; ‘yes’ to the question ‘do you know how to follow up patients with lung nodules that have been detected by LDCT screening?’ were several reasons that may be related to medical workers’ knowledge of LDCT screening for early-stage lung cancer. These possible reasons suggest that knowledge of LDCT in screening lung cancer needs to be improved among medical workers. There are several reasons to educate and improve the knowledge of LDCT in screening for lung cancer. First, nurses and technicians (especially nurses) showed little knowledge of LDCT in screening lung cancer. The nurse is an important post in a medical institution and the proportion of nurses in a medical institution is relatively high. Therefore, leaders in medical institutions should pay attention to nurses; for example, more education of the knowledge about LDCT in screening for lung cancer should be conducted for nurses. Second, medical workers who were more knowledgeable about lung cancer screening/treatment and limitations of LDCT screening believed that LDCT can effectively screen for early-stage lung cancer. This suggests that leaders in medical institutions or the government must facilitate and train medical workers on lung cancer-related information to improve their knowledge about LDCT screening for early-stage lung cancer. These may help more medical workers suggest high-risk residents to undergo lung cancer screening with LDCT. Several studies reported that the main barriers for medical workers to recommend residents to undergo LDCT screening were patients’ cost, potential harm of false-positive findings or patients’ lack of knowledge on the risk of lung cancer.25 26 27 This was partially similar to our findings, where our study showed that a high proportion of false-positive results and exposure to radiation were the main reasons medical workers did not recommend LDCT screening. This indicates that if the medical institution provides sufficient protective measures against radiation or actions to improve doctors’ ability to reduce false-positive results, medical workers will have sufficient knowledge of LDCT’s effectiveness to screen for early-stage lung cancer, leading to more medical workers recommending high-risk residents to do LDCT screening.

As discussed above, only 22.87% of residents knew that LDCT can effectively screen for early-stage lung cancer, and 66.06% of medical workers knew that LDCT can effectively screen for early-stage lung cancer. However, the rest of the residents and medical workers did not know that LDCT can effectively screen for early-stage lung cancer. Therefore, it is necessary to understand the pros and cons of LDCT screening for early-stage lung cancer. First, with increasing age, complications caused by pulmonary nodule biopsy and mortality caused by pulmonary nodule resection will increase accordingly. False-positive results will also increase when using LDCT for early-stage lung cancer screening. Furthermore, comprehensive LDCT screening for early-stage lung cancer in residents may lead to excessive examination and treatment; for example, how about the ability to interpret LDCT screening results? In fact, the older population who selected LDCT screening for early-stage lung cancer will reduce the potential life benefit regarding the effects of age on mortality and complication rate. Second, a study conducted in Italy showed that LDCT screening can increase the number of patients with early-stage lung cancer, leading to reduced lung cancer mortality in heavy smokers.8 28 A prospective study showed that the benefit increased with the extension of the screening time.29 Interestingly, active monitoring of non-solid or subsolid pulmonary lesions can help avoid unnecessary surgical resection of most inert or slow-growing cancers without affecting the effects of LDCT screening.30 To encourage residents to learn more about the pros and cons of LDCT screening, several aspects were needed. First, high-risk populations, such as smokers, should consider conducting LDCT screening regularly. Meanwhile, they

### Table 9 Continued

| Variables | Median (P<sub>25</sub>–P<sub>75</sub>) | Statistic | P value |
|-----------|-----------------------------------|-----------|---------|
| **Cost of chest CT in the physical examination centre (¥)** | | | |
| Yes | 261.00 (230.00–306.00) | 2120.0000 | <0.0001 |
| No | 0.00 (0.00–180.00) | | |
| **Number of cases diagnosed with early-stage lung cancer in the physical examination centre in year 2018** | | | |
| Yes | 5.00 (2.00–10.00) | 105.0000 | 0.9119 |
| No | 5.50 (0.00–12.00) | | |
| **Number of cases with diagnosed early-stage lung cancer in the physical examination centre in year 2019** | | | |
| Yes | 11.00 (5.00–17.00) | 99.5000 | 0.2375 |
| No | 4.00 (1.00–15.00) | | |
| **Number of cases diagnosed with early-stage lung cancer in the physical examination centre in year 2020** | | | |
| Yes | 10.00 (4.00–35.00) | 105.0000 | 0.3355 |
| No | 9.00 (2.00–10.00) | | |
should consider the degree of smoking. Regular LDCT screening for lung cancer might be more beneficial if the participants were heavy smokers. Participants who occasionally smoke, especially without any disease, should consult doctors about whether they need regular LDCT screening for lung cancer. Residents who are not a high-risk population should learn the pros and cons of LDCT screening through networks, books and other ways. In our study, we found several factors positively related to residents’ knowledge of LDCT screening for early-stage lung cancer, including having higher education level (master’s degree or higher and university/college), having commercial insurance, undergoing physical examinations one time/year and familiarity with lung cancer. These factors suggest that if residents want to know more about the pros and cons of LDCT screening, they should have higher education level, purchase commercial insurance, undergo physical examination once a year and be familiar with lung cancer. Therefore, the government must increase residents’ income, improve education level and increase the publicity of LDCT screening for early-stage lung cancer using various methods so that residents learn more about the pros and cons of LDCT screening. We cannot conclude whether the pros outweigh the cons of LDCT screening for early-stage lung cancer in medical workers or the contrary. However, in our study, we evaluated the level of knowledge about LDCT’s effectiveness to screen early-stage lung cancer in medical workers (table 7). We found that (1) medical workers were willing to select LDCT for lung cancer screening according to the high-risk population (OR 1.2507; p<0.0263); (2) medical workers believed that LDCT is the most effective lung cancer screening method based on the high-risk population (OR 3.7530; p<0.001); (3) medical workers were (general+quite+very) familiar with LDCT’s effectiveness to screen for early-stage lung cancer (all p>0.001); (4) medical workers knew the limitation and potential risk of LDCT screening for lung cancer (OR 1.7385; p<0.001); (5) according to the main reason medical workers recommend LDCT screening for lung cancer, medical workers were accord with the following reasons: LDCT screening for lung cancer is cost-effective, LDCT screening can reduce lung cancer mortality, referring to the Chinese Lung Cancer Screening Guidelines (all p<0.001); and (6) medical workers knew the main reason why they do not recommend LDCT screening for lung cancer, including a high proportion of false-positive results and exposure to radiation (all p<0.006). Therefore, based on the findings, it is possible for medical workers to know the pros and cons of LDCT screening and are willing to recommend high-risk populations to select LDCT screening for early-stage lung cancer.

Few studies evaluated LDCT set-up in a medical institution and discussed the factors that may affect LDCT set-up in a medical institution. However, conducting LDCT screening for early-stage lung cancer and discussing the potential factors that may affect LDCT set-up in a medical institution are likely to affect the knowledge of medical workers and residents. Therefore, paying more attention to the influencing factors and improving the rate of implementation of LDCT screening for lung cancer help to improve the knowledge structure of medical workers and enhance the self-care consciousness of residents, providing the basis for the secondary prevention of early-stage lung cancer screening. In our study, we first evaluated the current status of a medical institution, including the grade of the medical institution, administrative rank, whether they joined a medical alliance for pulmonic nodules/lung cancer, number of hospital beds that actually opened and average cost of the individuals who underwent physical examination (¥). Then we discussed the possible reasons that may be correlated with setting up LDCT screening. We found that indices such as the number of hospital beds that actually opened, and the total number of medical workers in the medical institutions/medical workers with associate and/or senior professional titles (radiologist/medical technician/respiratory doctor/thoracic surgeon) were significantly higher in the medical institutions setting up LDCT screening than those who did not. Similarly, medical institutions that did not set up LDCT screening had a lower grade level, administrative rank and average cost of patients who underwent physical examination or cost of chest CT in the physical examination centre than medical institutions that set up LDCT screening. These findings suggested that medical institutions with higher grades, higher administrative ranks and more radiologists/medical technicians/thoracic surgeons/clinicians were more willing to set up LDCT screening. Indeed, hospitals, such as West China hospitals, had the above characteristics; therefore, these types of hospitals may indeed have set up LDCT screening. However, most of the hospitals in China, especially in Sichuan province, did not like the West China hospital. This may affect setting up LDCT screening in medical institutions, leading to low knowledge of lung cancer and LDCT screening among medical workers. Finally, medical workers may recommend fewer high-risk residents for LDCT screening. However, this hypothesis needs to be verified in future studies. When establishing lung cancer screening with LDCT, a medical institution may consider several aspects, such as recruiting more medical workers, especially those with associate and senior professional titles. The government should put more effort into establishing LDCT screening for early-stage lung cancer; for example, providing funds for a medical institution to purchase LDCT, providing methods to increase the community resident’s income and reducing the cost of LDCT screening. Therefore, more medical institutions will carry out LDCT screening for early-stage lung cancer and encourage residents to pay attention to lung cancer and LDCT screening for early-stage lung cancer.

Limitation
The questionnaire was self-designed based on the purpose of the study and related studies. Although reliability and
validity are high, the questionnaires need to be applied in other studies to confirm their reliability and validity. Additionally, nurses account for the largest proportion of medical workers, but community residents often have direct contact with primary care doctors, who are more likely to give a screening suggestion to the population. Future studies are needed to discuss the view of primary care doctors in more areas of China. Third, there is no information on lung cancer knowledge popularization and health education, which is known to be an important factor affecting the awareness rate. Fourth, no knowledge level of the pros and cons of LDCT in different study groups was discussed. Finally, the medical workers’ concepts of pros outweighing the cons for LDCT screening for early-stage lung cancer or the contrary were not evaluated.

**CONCLUSION**

Community residents were less aware of lung cancer as well as LDCT. There are many possible reasons related to residents’ and medical workers’ knowledge about LDCT screening for early-stage lung cancer. Medical institutions should provide more educational intervention, and the government should provide resources to residents, medical workers and medical institutions.

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