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The feasibility and cost-effectiveness of implementing mobile low-dose computed tomography with an AI-based diagnostic system in underserved populations

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Abstract

Background Low-dose computed tomography (LDCT) significantly increases early detection rates of lung cancer and reduces lung cancer-related mortality by 20%. However, many significant screening barriers remain. This study conduct an initial feasibility and cost-effectiveness analysis of a community-based program that used a mobile low-dose computed tomography (LDCT) scan unit and discuss the operational challenges faced during its implementation.

Methods This study was conducted in rural areas in Fujian Province, China from July 2022 to August 2022. Individuals aged 40 years and above who had not previously undergone LDCT and who were socioeconomically marginalized were included. Participants received a LDCT program from a multidisciplinary research team. Physicians analyzed the images with the assistance of artificial intelligence "InferRead CT Lung Research" and completed structured reports on their impressions. The primary evaluation indicators for mobile LDCT screening effectiveness were the lung cancer detection rate and diagnosis rate, while the main evaluation indicators for cost-effective analysis were the cost-effective ratio and early detection cost index.

Results A total of 10,159 individuals participated in this study. The detection rates of suspected lung cancer cases and confirmed cases were 1.06% ($n = 108$) and 0.7% ($n = 71$), respectively. The cost of lung cancer screening (LCS) was ¥1,203,504 (US$188,847.71), the average cost per screening was ¥118.47 (US$18.65), and the cost effective ratios for the detection of suspected lung cancer and confirmed lung cancer were ¥11,143.56 (US$1,753.29) and ¥16,950.76 (US$2,669.94), respectively. The early detection cost indices for suspected lung cancer were 0.09 and 0.13 for confirmed lung cancer, respectively.

Conclusion This LDCT with artificial intelligence model for LCS holds economic promise for reducing health disparities in underserved areas and promote larger populations in similar low-income country.

Keywords Artificial intelligence, China, Early detection of cancer, High-risk population, Lung cancer

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Introduction

Lung cancer stands out as the most frequently diagnosed malignancy and the leading cause of cancer-related deaths globally, particularly in low- and middle-income countries (LMICs) [1]. According to the GLOBOCAN database, there were an estimated 2,093,876 new cases and a total of 1,761,007 deaths in 2018, with 61% of new cases and 65.3% of mortalities occurring in LMICs [2]. This substantial burden is compounded by the fact that approximately 75% of lung cancer patients are diagnosed at an advanced or metastatic stage, resulting in an overall 5-year survival rate of 0-13% [3]. This risk is notably heightened for underserved populations, such as racial/ethnic minorities, individuals residing in rural areas with limited access to care, and other socioeconomically marginalized populations [4]. In contrast, patients detected at an early stage experience an overall survival rate of up to 80% [5]. These significant differences underscore the potential to improve survival rates in high-risk populations through early detection via lung cancer screening (LCS).

Results from a rigorous series of randomized controlled trials (RCTs) have unequivocally demonstrated the efficacy of LCSs, utilizing low-dose computed tomography (LDCT), in mitigating the mortality associated with lung cancers in high-risk individuals [6]. Furthermore, evidence supporting its cost-effectiveness has been firmly established in high-risk individuals of lung cancer among 55–75 years old [7]. Despite global recommendations by LCS guidelines, however, the rates of LCS adoption remain alarmingly low on a global scale. For instance, in the United States, the adoption rate only increased from 3.8 to 16.3% between 2010 and 2017 [8, 9]. Similarly, the overall adoption rate of LDCT scans among all individuals at high-risk for lung cancer in China stood at a mere 33% [10] with significantly lower rates in less developed regions.

Moreover, disparities between urban and rural areas are evident in the utilization of LDCT screening. For instance, within Manchester's Lung Health Check program, LCS attendance was 22% lower in the most deprived population than in the least deprived population [11]. This marked discrepancy can be attributed to structural and regional obstacles, such as a lack of transportation, extended travel distances, poor road conditions, extreme poverty, and limited access to healthcare resources, particularly in rural areas [12]. Hence, the implementation of mobile computed tomography (CT) scanners and a comprehensive "lung health-checks" program holds significant potential for enhancing the accessibility of LCSs, especially among underserved populations.

In recent years, the use of mobile CT units for LCSs has been explored in various countries, including Australia, Japan, Kenya, the UK, and Brazil, with promising preliminary results [13, 37]. For instance, a community-based mobile CT scan unit proved to be an effective strategy for LCSs in Yorkshire, UK, engaging participants at high risk of lung cancer from deprived areas in Manchester's Lung Health Check program [14]. In the western regions of China, several researchers have also explored the feasibility of using mobile CT screening units [15, 16]. However, while presenting preliminary positive evidence, these studies may have overlooked socioeconomically marginalized populations that potentially represent different lung cancer profiles.

Due to the potential for false-positive results from LDCT, which can lead to unnecessary tests, invasive procedures, overdiagnosis, incidental findings, increased distress, and, in rare cases, radiation-induced cancer, artificial intelligence (AI) has infused fresh vitality into the medical sphere [17]. The use of machine learning algorithms for AI has shown remarkable efficacy in data processing and diagnostics and holds promise for mitigating many of these concerns. Previous studies on AI have suggested its potential as a secondary reader for mobile CT images, which is particularly beneficial in underdeveloped regions that lack thoracic imaging experts [18]. However, current evidence on the real-world application of combining mobile CT screening and AI technology in China remains limited [36]. Additionally, the cost-effectiveness of employing AI in mobile CT screenings in underserved areas is unclear.

Distinctive demographic differences exist between Western countries and China, such as a high smoking prevalence often observed in Western lung cancer patients versus a majority of lung cancer cases occurring among women and non-smokers in China. For example, according to Yang's study, the incidence of lung cancer among never-smokers is significantly higher in China than in the United States. Therefore, including high-risk individuals in China's lung cancer early detection programs, regardless of their smoking history, is appropriate [19]. While studies from Western countries have explored the cost-effectiveness of utilizing mobile CT units for LCSs, the cost-effectiveness of using mobile CT units for LCSs in high-risk populations with varying levels of lung cancer risk remains unclear.

This study aimed to describe pilot findings from an integrated non-profit program for lung cancer prevention in rural China. The 'Happy Homestead' Village Mutual Aid Project for LCS combines a mobile LDCT unit with an AI-based diagnostic system, on-site consultations, and health education (e.g., smoking cessation) tailored for high-risk individuals. The 'Happy Homestead' Village Mutual Aid Project was a prospective, community-based intervention focused on LCSs in rural areas. Herein, we present its initial feasibility and cost-effectiveness analysis results and discuss the operational challenges faced during its implementation.

Methods

Prior to the start of the study, this project was approved by the human ethics committee of Fujian Medical University [2023075]. The homestead program screening sites were located within rural areas of seven cities in Fujian Province, China and are shown in Fig. 1. Owing to local socio-economic conditions and unfavorable traffic for residents, these sites had lower levels of medical resource allocation than the provincial average, as evidenced by the number of hospitals and health centers in the area and the number of physicians per thousand individuals (e.g., Ningde, 2.1/1,000; Sangmin, 2.0/1,000; Nanping, 1.9/1,000; and Longyan, 1.9/1,000).

Participants

From July 2022 to August 2022, the municipal government and community health centers were responsible for promoting the study to eligible individuals through posters and media announcements. The inclusion criteria were as follows: individuals aged 40 years and above who had not previously undergone lung cancer screening and who were socioeconomically marginalized (e.g., residents of impoverished rural households or recipients of income support). The exclusion criteria included individuals who were previously diagnosed with lung cancer or who were unwilling to undergo mobile CT examination. Community doctors contacted potentially eligible individuals and explained the study. Eligible volunteers were invited to participate in the project by a doctor who answered questions that arose, obtained consent and conducted pre-registration procedures. Participants spent an average of 2.5 h volunteering for the study.

Procedures

Between September and December 2022, a team of trained multidisciplinary professionals, including doctors, nurses, radiologists, and patient navigators, implemented the LCS program. This program utilized a combination of census and convenience sampling strategies to identify participants. In rural areas with a high incidence of lung cancer, such as Fuan City and the county of Zherong, a census strategy was employed for screening eligible volunteers, while in other regions, interested participants contacted members of the study team to be screened for enrollment. The division of labor used among the members of the study team was as follows: patient navigators, composed of volunteers and local community healthcare providers, were responsible for appointment scheduling, data collection, communicating results, and providing resources for further evaluation or treatment (Chinese Expert Consensus on Diagnosis and Treatment of Pulmonary nodules, 2018 edition) [20]. Nurses were specifically responsible for providing smoking cessation education (for smokers) or lung cancer health related counseling (for both smokers and non-smokers). Doctors and radiologists were responsible for recording clinical information, performing scans, transmitting CT images, analyzing the images with the assistance of AI (nodules were detected and classified by the AI system) and completing structured electronic reports. Figure 2 depicts the sequence of procedures and roles of personnel used in the study.

Mobile CT unit with remote AI assistance

The mobile CT unit consists of an advanced, compact diagnosis room equipped with an LDCT inspection system from DUNLEE Corporation, an air suspension platform, radiation protection shielding, an intelligent imaging cloud system, a 5G communication module, and an automatic power supply system. The scanning parameters were standardized as follows: tube current ranging from 10 to 420 mA, tube voltage from 80 to 140 kV, small focus size at 0.7–1.2 mm, and large focus size at 1.2 mm. Supported by robust hardware and technology, CT 16 achieves exceptional image quality–spatial resolution, assessed using the CATPHAN Phantom model (tool to measure maximum performance characterization of LDCT and the sensitometry measurements required for radiation therapy), reaching 21.8 lp/cm at MTF = 0% and 14 lp/cm at MTF = 10%, and the density resolution can achieve 3 mm at 0.3%.

The AI lung nodule detection system we used, InferRead CT Lung Research (ICLR), was developed by Beijing Infervision Technology Co., Ltd. (China). The malignancy-risk prediction in ICLR demonstrated high accuracy for primary lung cancer risk prediction [21], based on training from 11,205 CT scans with 3,527,048 image slices collected from hospitals in China. It is the first automated lung nodule detection product to receive approval from both the U.S. Food and Drug Administration and the China National Medical Products Administration. ICLR focuses on automatic pulmonary nodule detection and classification to identify primary lung tumors through a detection and risk prediction model. Additionally, it includes lung nodule parameters (such as nodule volume) to assist doctors in making diagnoses. ICLRs have been widely used in top-tier hospitals in China to aid in diagnosing lung nodules [21].

Data analysis

The primary evaluation indicators for mobile LDCT screening effectiveness are the detection rate and diagnosis rate, while the main evaluation indicators for cost-effective analysis are the cost-effective ratio (CER) and Early Detection Cost Index (EDCI) [22]. The diagnosis

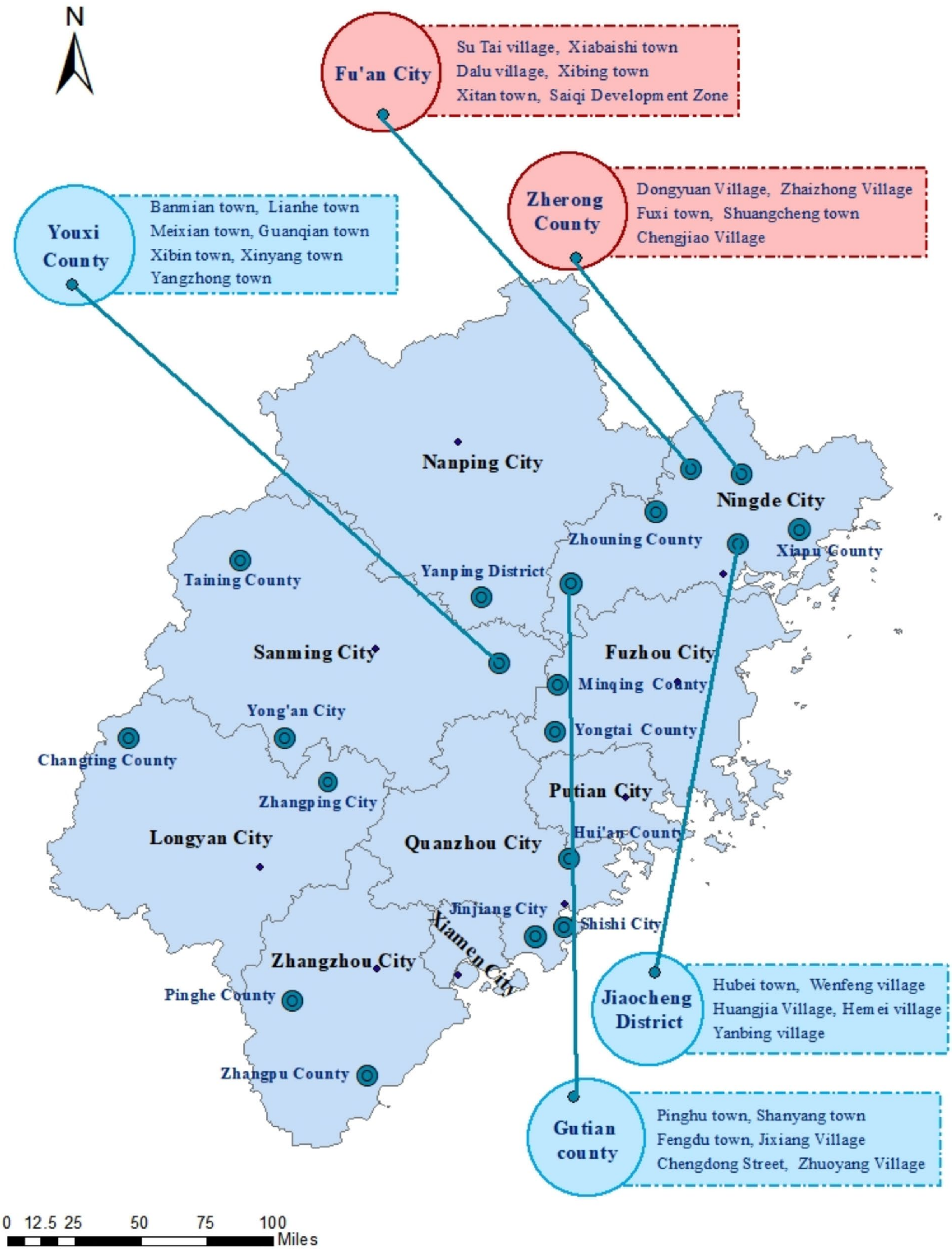

Fig. 1 A map highlighting the locations of the lung cancer screening sites in the Happy Homestead Village Mutual Aid Project

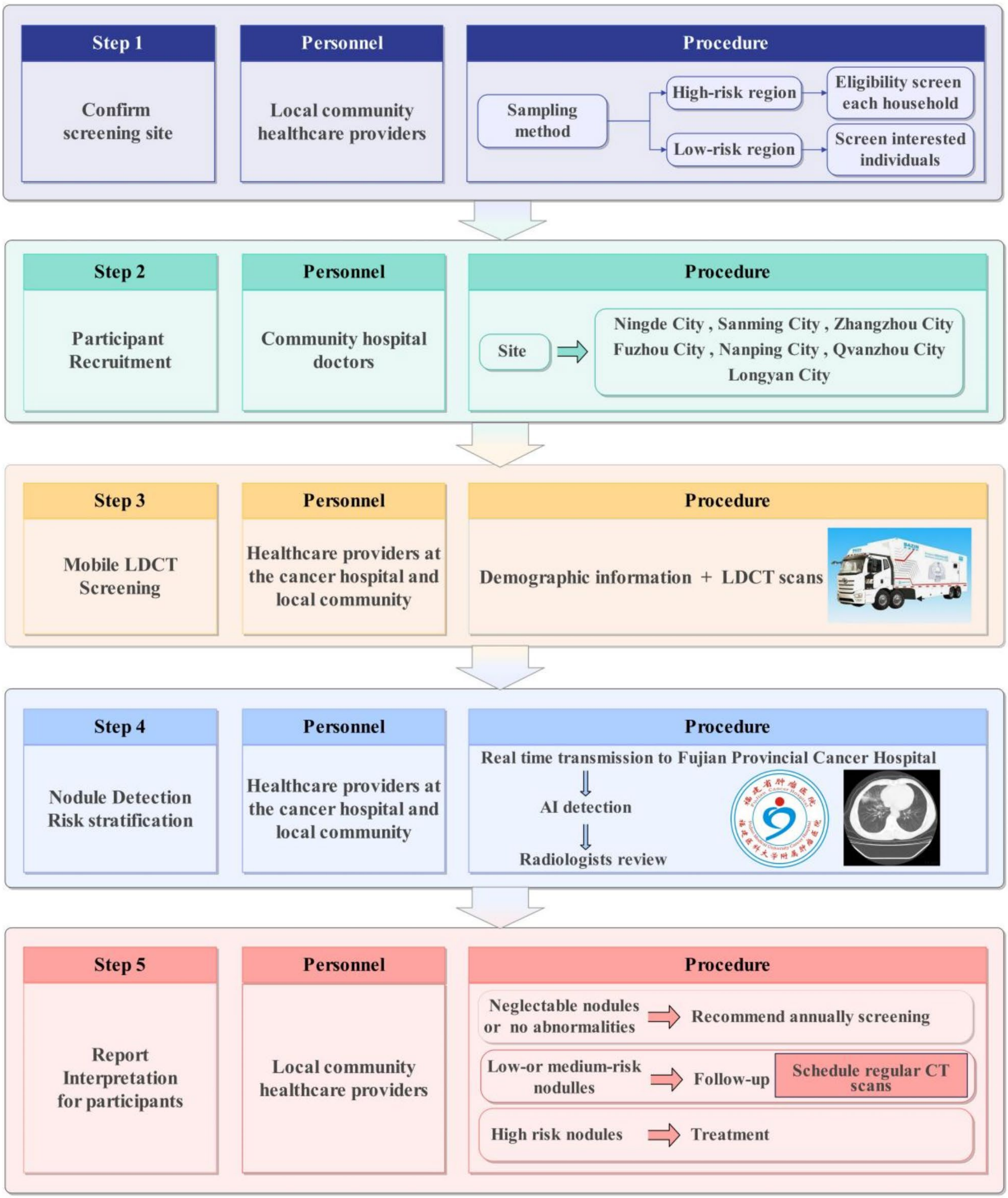

Fig. 2 The flowchart of the Happy Homestead Village Mutual Aid Project

rate is the proportion of lung cancers confirmed through pathological examination, while the detection rate is the proportion of lung cancers identified by the AI system. CER is defined as the cost required to detect one case of lung cancer through screening. The average cost of early case detection includes direct and indirect costs. Direct costs refer to medical and non-medical costs directly incurred during the screening process. The

Table 1 Baseline characteristics of participants

Characteristic	Data
Gender	
Male	5201 (51.20%)
Female	4958 (48.80%)
Smoking history	
Never	5011 (49.33%)
Quit	897 (8.83%)
Current smoker	4251 (41.85%)
History of COPD	
Yes	2760 (27.17%)
No	7399 (72.83%)
Age (years old)	59.20 ± 3.10
History of malignancy	
Yes	327 (3.22%)
No	9832 (96.78%)
Educational level	
Primary school or below	4021 (39.58%)
Junior middle school	3073 (30.25%)
High school	2036 (20.04%)
Vocational diploma	769 (7.57%)
University or above	260 (2.56%)
Monthly income (CNY)	
≤ 3000	4698 (46.24%)
3000–5000	2916 (28.70%)
5000–8000	2158 (21.24%)
≥ 8000	387 (3.81%)

former involves costs of LDCT examinations and biological testing, while the latter includes non-medical costs such as transportation expenses. Indirect costs refer to expenses not related to the medical services themselves and include promotional expenses, training expenses, staff salaries, and any lost wages incurred by screened participants during their participation in the project. The EDCI represents the ratio of the average cost of detecting early cases (CER) to the per capita gross domestic product (GDP). The lower the EDCI is, the lower the cost of screening and the greater the health benefits obtained, making cancer screening and early diagnosis and treatment more cost-effective. The average annual salary in Fujian Province in 2022 was ¥65,392 (US$9,342), and the average missed work time was 2.5 h [23]. The per capita GDP of Fujian Province in 2022 was ¥126,829 (US$18.118) [23].

The think-aloud method was employed to measure the feasibility and collect operational challenges of the project [24]. The think-aloud method is a qualitative data collection method widely utilized in the feasibility evaluation of public health projects. This method involves gathering verbalizations regarding productive thinking and understanding the development of thought in individuals [24]. During the think-aloud stage, participants and research team members were asked to express their feelings and thoughts regarding the project's feasibility and collect information on operational challenges. Researchers recorded these comments.

Results

During the study period, 10,159 eligible individuals across screening sites were recruited and underwent mobile-unit screening with LDCT. Among these individuals, the average age was 59.2 ± 3.1 years. Nearly half of the participants (51.20%) were male (n = 5,201). The detail is shown in Table 1.

The feasibility results of the program

A total of 179 participants were detected as lung cancer patients, 108 were suspected lung cancer cases, and 71 were confirmed lung cancer cases. Therefore, the detection rate of lung cancer cases was 1.76% (n = 179), and the diagnosis rate was 0.70% (n = 71). Among the 71 individuals diagnosed with lung cancer on imaging, 51 were pathologically confirmed through procedures such as surgery or biopsy. Among these confirmed cases, 3 had squamous cell carcinomas, 46 had adenocarcinomas (including 8 with atypical adenomatous hyperplasia (AAH)), 11 had adenocarcinoma in-situ (AIS), 14 had minimally invasive adenocarcinomas (MIS), 10 had invasive adenocarcinomas, and 2 had metastatic tumors.

The cost-effectiveness analysis results

The total cost of LCSs was calculated to be ¥1,203,504 (US$188,847.71), with direct costs amounting to ¥650,000 (US$102,176.68), which included LDCT screening expenses. The indirect costs of the LCSs totaled ¥553,504 (US$86,671.03) and included staff salaries of ¥312,000 (US$49,031.12), publicity expenses of ¥1,000 (US$157.88), losses of wages of ¥180,504 (US$28,381.03), and accommodations and meal expenses of ¥60,000 (US$9,101.00). Thus, the average cost per screening was ¥118.47 (US$18.65), with CERs for the detection of suspected lung cancer and confirmed lung cancer of ¥11,143.56 (US$1,753.29) and ¥16,950.76 (US$2,669.94), respectively. According to the Fujian Statistical Yearbook 2022, the per capita GDP was ¥126,829 (US$19,959.52), yielding an EDCI of 0.09 for suspected lung cancer cases and 0.13 for confirmed lung cancer cases.

The program's operational challenges

Despite the effectiveness of the lung cancer screening program, several operational challenges were identified through the think-aloud method.

First, although the screening program was been funded by the local government since its initiation, future demand from other projects may divert funds away from this cancer screening program. Thus, securing independent and stable funding for the screening program is necessary.

Second, there were insufficient human resources for health services. The implementation of the project requires the assistance of many parties, including doctors, nurses, radiologists, community healthcare providers, and community volunteers. However, there is an unbalanced distribution of professional health workers in China due to the urban-rural gap and regional disparities. Consequently, variations in human health resources across different regions may affect the success of the project.

Third, the project's publicity was insufficient. Some team members noted that the project was not advertised enough, leading to a lack of trust among high-risk individuals regarding healthcare providers, which may impact project implementation.

Fourth, the management of resident health records was not standardized. In areas with a high incidence of lung cancer, our project included high-risk individuals based on local resident health records. However, these records may not be updated in a timely manner, resulting in the inclusion of some low-risk individuals and the exclusion of some high-risk individuals.

Finally, providing logistics and sourcing services was essential. This project was conducted in remote areas where logistical resources, such as screening resources, health care resources, internet connectivity and traffic conditions were not stable. Therefore, future studies will need to guarantee online connectivity to ensure that the project proceeds smoothly.

Discussion

This study presents findings from a large, underserved population from rural Eastern China who participated in an LCS program that utilized mobile CT scanners and remote AI diagnostic assistance. The program employed census (high incidence areas) and convenience sampling (non-high incidence areas) screening strategies in areas at high-risk for lung cancer and non-high-risk areas, respectively, to identify underserved individuals, providing them with convenient and immediate access to LDCT screening. Our findings indicate that the 'Happy Homestead' Village Mutual Aid Project had high rates of participation as well as high rates of detection of abnormal results that promoted early treatment. Notably, this multidisciplinary driven, patient navigation-guided, mobile LDCT program was found to be cost-effective in underserved rural areas of China and was found to be a feasible solution for increasing the rate of LCSs in underserved populations.

Health disparities and health equity impact

Our study achieved a participation rate greater than 90%, which surpassed that of real-world reports across various cancer screening modalities and was comparable to that of controlled clinical trials [25, 26, 27]. This finding suggests that patient navigation services likely contributed to its high completion rate, as demonstrated by their efficacy in other cancer screening programs (e.g., breast cancer, colorectal cancer) [28]. Therefore, the impact of patient navigators on mobile LDCT programs needs to be further explored and promoted.

In addition, consistent with other mobile screening initiatives, the mobile LDCT program in this study effectively addressed key barriers to screening such as difficulty accessing medical care, lack of transportation, insufficient awareness of screening, and the absence of referrals to screenings in underserved rural areas [29, 30, 31]. By providing convenient, nearby screening services, the LCS program facilitated early detection of lung cancer.

Through the use of an AI-based diagnostic system, individuals in underserved communities were virtually connected with specialist expertise, and by transmitting diagnostic images and related reports, it was possible to overcome local shortages of medical services and enhance the quality, efficiency, and timeliness of LCSs. Consequently, disparities were reduced and health equity related to the early detection of cancer among individuals residing in underserved rural areas improved.

Early detection and management

This study identified early abnormal results in a significant number of participants–1.06% of participants were found to have high-risk pulmonary nodules and 0.7% were diagnosed with lung cancer. The lung cancer detection rate was slightly higher than that reported in Western China (0.55%, $n = 19517$), slightly lower than the national overall level (0.96%), and lower than that reported in the United States (2.2%, $n = 550$) and the United Kingdom (3%, $n = 1384$) [16, 32]. These differences may be attributed to variances in the demographic and health profiles of the population under study. While other studies were conducted in high-risk populations who were individually assessed as being at high-risk for lung cancer, our study did not assess individual risks for lung cancer and included only individuals aged 40 years and above who had not previously undergone LCSs. Our approach not only facilitated early detection but also ensured the timely management of abnormal results. Most patients with high-risk pulmonary nodules and lung cancer receive timely treatment at the hospital. Therefore, the establishment of a regional tumor prevention and control data network to facilitate the sharing of more medical resources is supported by our study findings.

Cost-effectiveness

By utilizing real-world data from China, this study presents the first cost-effectiveness analysis of a mobile LDCT program with an AI-based diagnostic system. We employed the EDCI, an evaluation indicator, commonly used in health economics evaluations, to estimate the cost-effectiveness of our mobile LDCT program. The findings revealed that the average cost per screening was ¥118.47 (US$18.65), with an EDCI of 0.09 for suspected lung cancer and an EDCI of 0.13 for confirmed lung cancer. These values were lower than those reported in other Chinese cities, such as Haikou City (0.48), Xuzhou City (1.22), and Jinan City (2.24) [33, 34, 35]. Generally, when the EDCI is less than 5, early diagnosis and treatment of cancer are considered highly cost-effective [22]. In addition, the lower the EDCI is, the lower the cost of screening and the greater the health benefits obtained, making cancer screening and early diagnosis and treatment more cost-effective. Thus, our results indicate that this mobile LDCT program is cost-effective based on this indicator.

Furthermore, our estimated per-patient cost of ¥118.47 (US$18.65) is higher than that of other mobile LDCT programs, such as the "Lung Health Checks" mobile LDCT project in Manchester, UK (per-patient cost = $7.7) [11], but significantly lower than that of traditional LDCT programs in rural areas, such as the largest rural LCS program in the United States (per-patient cost = US$430) [36]. This can be explained by the fact that mobile LDCT services are purchased collectively, which reduces the cost per person screening by increasing the number of screenings performed. If each patient underwent a fixed CT scan individually at the hospital, the cost per screening session would be much greater. This further confirms the cost-effectiveness of our LCS program.

Challenges and implications for practice

Our findings demonstrate the feasibility and potential benefits of implementing a mobile LDCT program with an AI-assisted diagnostic system in underserved rural areas, which has several limitations in terms of the study design and project outreach.

Due to the limitations of project outreach, first, mobile CT screening units could be scaled up to extend their service delivery areas to include additional underserved communities across China and other LMICs. The successful implementation of this LCS program requires addressing several operational challenges. The key to success is the cooperation and policy support of local governments. They need to mobilize a diverse workforce, including medical and social work departments, and promote multidisciplinary cooperation to address the issues of insufficient human resources and logistical constraints. Enhancing public awareness and trust in healthcare providers is crucial. Local governments should utilize modern media, such as television, the internet, public posters, and celebrity endorsements, to improve public awareness and consultation efforts. This approach aims to boost residents' health beliefs and strengthen doctor-patient trust. The standardization of health records is another critical factor. The Chinese Ministry of Health should lead efforts to reform the management of urban and rural residents' health records. Local medical and health institutions should progressively standardize and develop these records, ensuring that they are shared with the LCS program to facilitate better project management.

Second, given the low LCS rates nationwide and the elevated risk of lung cancer in rural populations, integrating this LCS program into China's public health initiatives is recommended. Local governments could support the costs of operating a mobile screening program. Deploying mobile screening units to rural or remote areas to offer free, one-stop health services would increase health awareness and encourage LCS behaviors, while also enhancing the overall level of basic healthcare.

Third, the cost-effectiveness of mobile CT, as determined in our study, informs policymakers, aids in cancer screening resource allocation decisions and promotes decentralized mobile screening models. Furthermore, navigation assistance "assessment-to-timely screening" initiatives through existing regional-medical consortia facilitate transparent sharing of patient records, including imaging and biopsy results, across facilities; this ensures effective triage management of high-risk lung cancer populations.

There are several limitations in the study design. First, as this was a preliminary feasibility assessment with a limited observational period and dataset scope, sociodemographic and other participant data, such as occupation, medical history, smoking status and other risk factors for lung cancer, were not collected. Future studies are needed to collect adequate participant information, assess patient satisfaction with the LCS program, evaluate implementation efficacy, and track long-term follow-up outcomes. Second, the present study primarily included individuals who had not undergone LDCT screening. Future research could consider including populations at greater risk for lung cancer to compare the differences in screening efficacy and cost-effectiveness by using various screening strategies. Third, although preliminary evidence of cost-effectiveness for a mobile CT program was shown in this study, future evaluations should directly compare the cost-effectiveness of mobile CT screening versus fixed CT scanning in hospitals.

This study presents the feasibility and cost-effectiveness analysis results of a large population participating in an LCS utilizing mobile CT scanners with remote AI diagnostic assistance. The study was conducted in underserved rural areas of Eastern China. The mobile screening model used in this study addresses multiple LCS barriers encountered in underserved rural areas, promotes LCS behaviors and facilitates the early detection of lung cancer. Importantly, this model of a mobile LDCT with AI holds promise for reducing health disparities in underserved areas and could be expanded to larger populations in similar LMIC contexts.

Abbreviations

AI	Artificial intelligence
CER	Cost-effective ratio
EDCI	Early detection cost index
GDP	Gross domestic product
ICLR	InferRead CT Lung Research
LCS	Lung cancer screenings
LDCT	Low-dose computed tomography
RCTs	Randomized controlled trials

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Author contributions
WSC had full access to all the data and takes responsibility for the integrity of the data and the accuracy of the data analysis. YL contributed to the writing of the manuscript. XJL contributed to writing of the manuscript. XJL contributed to the study design, data collection, data analysis and interpretation, and writing of the manuscript. FFH and YZH contributed to the recruitment, data collection and interpretation, and writing of the manuscript. WTC and YLL contributed to the study design, coordination, interpretation, and writing of the manuscript. FFH contributed to the overall study design, interpretation, writing of the manuscript and follow-up connection and treatment of patients in this study. All authors read and approved the final manuscript.

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Data availability
All data generated or analyzed during this study are included in this published article. The datasets are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate
This project was approved by the human ethics committee of Fujian Medical University [2023075]. Informed consent to participate was obtained from all of the participants in the study, and it is also in compliance with the Helsinki Declaration.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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