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PERSONAL POINT OF VIEW *Open access*

The importance of organized lung cancer screening: A personal point of view

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Abstract
Lung cancer is the leading cause of oncology mortality worldwide. In the last two decades, low dose CT lung cancer screening has established itself as the method of choice in high-risk populations. Many challenges, however, still arise – what are the best methods to reach those who benefit from screening? The question of incidental and additional findings is more than just a diagnostic one – it is also a medico-legal one. The definition of who is seen as high risk is also evolving, with a special focus on never-smokers. Finally, LCS programs were mainly developed in high income countries. Currently, it is unknown whether these data can be transferred and to what extent to low- and middle-income countries. This paper will demonstrate the current dilemmas in lung cancer screening – from a purely personal point of view.
Keywords: equity, low-dose computed tomography, lung cancer, screening

Introduction

Lung cancer is the leading cause of cancer-related mortality worldwide, accounting for approximately 1 million deaths each year. In Hungary, lung cancer mortality is approximately 8,500 deaths annually, while in Serbia it is around 4,500 (1,2). Unfortunately, the disease is often asymptomatic for a prolonged period. More than 75% of lung cancer cases detected outside screening programmes are diagnosed at an advanced stage, typically stage IIIB or beyond. Common symptoms include persistent cough, dyspnoea, weight loss, and haemoptysis. At present, potentially curative treatment, such as surgery or definitive local radiotherapy, is primarily available to patients with localized disease. Therefore, identifying as many cases as possible at an early stage is of paramount importance.

As lung cancer became an increasingly important public health problem during the first half of the 20th century, several efforts were undertaken to detect the disease at an earlier stage. Since the 1950s, screening approaches have included chest radiography, sputum cytology, or a combination of the two. Although these campaigns—including the Johns Hopkins screening trial and the Czechoslovakian screening project—were able to identify early-stage lung cancers and, in many cases, demonstrated clear benefits at the individual level, none was able to demonstrate a population-wide reduction in lung cancer mortality.

With technological advances and the introduction of computed tomography (CT), the ELCAP trial led by Henschke and colleagues demonstrated for the first time that very early-stage lung cancer could be detected using non-contrast, low-dose chest CT. Subsequently, the National Lung Cancer Screening Trial (NLST), which included more than 40,000 participants, demonstrated that low-dose CT screening could reduce lung cancer mortality by 20% over 10 years in a high-risk population (3). In Europe, the NELSON trial, conducted in the Netherlands, demonstrated an even greater benefit, with a 27% reduction in lung cancer mortality (4).

Based on these results, lung cancer screening with low-dose computed tomography (LDCT) is now recommended and reimbursed in the United States for high-risk populations, generally individuals aged 50–80 years with a substantial history of tobacco exposure. Nevertheless, implementation remains slow, with reported uptake of only approximately 11% in 2025 (5).

Lung cancer screening faces several important challenges, and a few of these will be considered here. In Europe, only a limited number of countries have established nationwide screening programmes. Croatia was among the front-runners, having initiated screening in 2017 (6). In England, screening has been gaining momentum, with a programme aiming to reach 100% of eligible individuals by 2030 (7). Germany has introduced a lung cancer screening measure under which eligible individuals may choose to undergo screening; however, there is currently no fully organized programme actively recruiting eligible participants. In most other European countries, screening remains limited to pilot programmes, although countries such as France are preparing for nationwide implementation, with a programme anticipated by 2029.

In **Figure 1**, typical low-dose computed tomography images of a peripheral centrally located adenocarcinoma obtained through a lung cancer screening programme are presented.

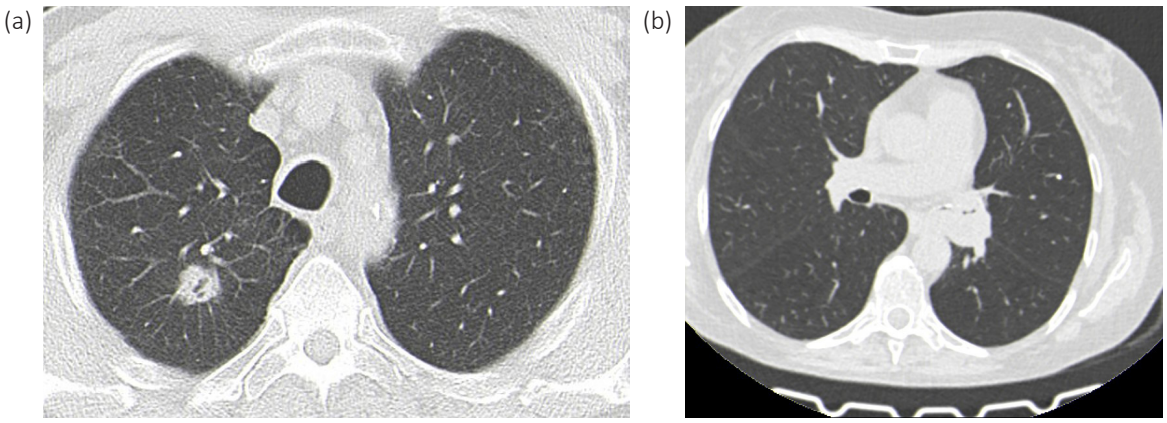


Figure 1. Low-dose computed tomography image of (a) peripheral adenocarcinoma, (b) centrally located adenocarcinoma.

Challenges in participation

Screening trials generally achieve substantially higher adherence than is observed when programmes are implemented in routine healthcare systems. Individuals who are most likely to benefit from screening are not necessarily those who are easiest to reach. People with lower educational attainment, lower socioeconomic status, limited access to healthcare, or geographical barriers may be less likely to participate. Paradoxically, these groups may also have a higher prevalence of smoking and other risk factors for lung cancer. Consequently, simply establishing screening centres and inviting eligible individuals may not be sufficient to achieve an equitable reduction in mortality.

Alternative models of service delivery may therefore be required. Mobile screening units can bring low-dose CT directly to communities that are geographically distant from conventional medical centres, reducing the practical barriers associated with travel and time away from work or family responsibilities. Such approaches may be particularly valuable in rural or underserved areas. Importantly, however, accessibility is not solely a geographical issue. Cultural, educational, and socioeconomic barriers can also influence participation.

Community-based interventions may therefore play an important role. Trained community mediators, healthcare workers, and patient ambassadors can help explain the purpose of screening, address misconceptions, and support individuals throughout the screening pathway. Their role may be particularly important for people who have limited previous interaction with the healthcare system. A trusted individual from within the community can often communicate the benefits and limitations of screening more effectively than a conventional invitation letter.

In the SOLACE project, we have been working specifically with these populations. Although these data are still under publication, I can share that our experience in Hungary suggests that mobile CT screening—using dedicated vehicles to bring screening services directly to communities—can help overcome geographical barriers and improve access among disadvantaged populations. In addition, trained mediators or patient ambassadors who work within local communities can make an enormous difference by demonstrating that lung cancer screening is an important preventive intervention and that it can be accessed easily and subsequently managed appropriately.

Another important issue is the screening of women, who are often underrepresented in lung cancer screening trials. For example, in the NELSON trial, lung cancer mortality in women appeared to be lower than in men by the ninth year of follow-up. However, because the number of women included in the study was relatively small, these findings did not reach statistical significance by the tenth year. Furthermore, women appear to have a higher proportion of adenocarcinomas, and there is evidence suggesting that female individuals who smoke may have a higher risk of developing lung cancer than men with a comparable cumulative smoking exposure (8).
Well-organized screening programmes should therefore aim to reach the highest possible proportion of eligible individuals, including those with lower educational attainment and younger people within the high-risk smoking population.

Pathways after screening - comorbidities and additional findings

Screening is not simply a single imaging test; it is a longitudinal process that may involve repeated examinations, assessment of pulmonary nodules, additional diagnostic imaging, multidisciplinary review, biopsy, treatment, and long-term follow-up. A programme must therefore have sufficient capacity not only to perform LDCT examinations but also to manage abnormal findings appropriately and without unnecessary delays.
This is particularly relevant because screening inevitably generates indeterminate findings and additional abnormalities. An effective programme needs clearly defined protocols for the assessment and follow-up of pulmonary nodules, as well as standardised approaches to clinically relevant incidental findings. Without such pathways, screening may increase unnecessary investigations, patient anxiety, healthcare costs, and potentially avoidable invasive procedures.
Although the primary objective of LDCT is the evaluation of the lung parenchyma and pulmonary nodules, the scan also includes other anatomical structures, including the mediastinum and lymph nodes, the heart and coronary arteries, the great vessels, bones, thyroid gland, and portions of the upper abdominal organs, including the liver, spleen, kidneys, and adrenal glands. Technically, current low-dose CT protocols are optimized to depict the lung parenchyma and pulmonary nodules very effectively, but this may come at the expense of reduced image quality for some solid organs. A 2024 survey among European radiologists found that more than 50% considered LDCT an unreliable method for assessing solid organs outside the lungs (9).
Because lung cancer screening is performed primarily in individuals over 50 years of age, it is important to remember that numerous incidental findings are common in this population. More than 50% of individuals may have renal or hepatic cysts, while thyroid nodules and adrenal hyperplasia are also relatively frequent.

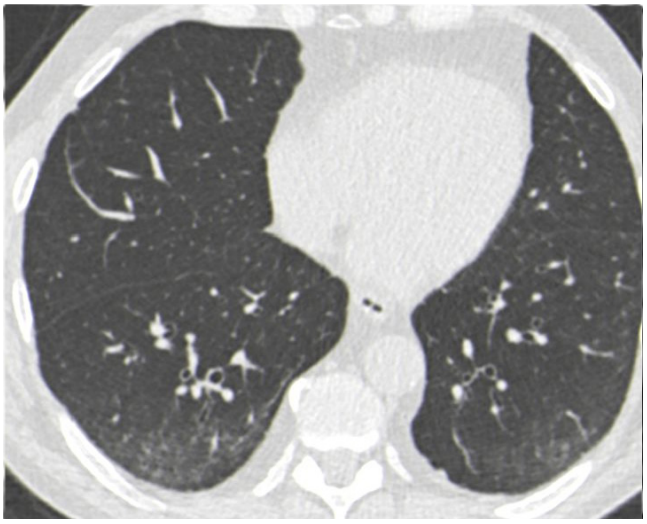


Figure 2. Low-dose computed tomography image of an additional finding - interstitial lung abnormality - diagnosed clinically as idiopathic pulmonary fibrosis.

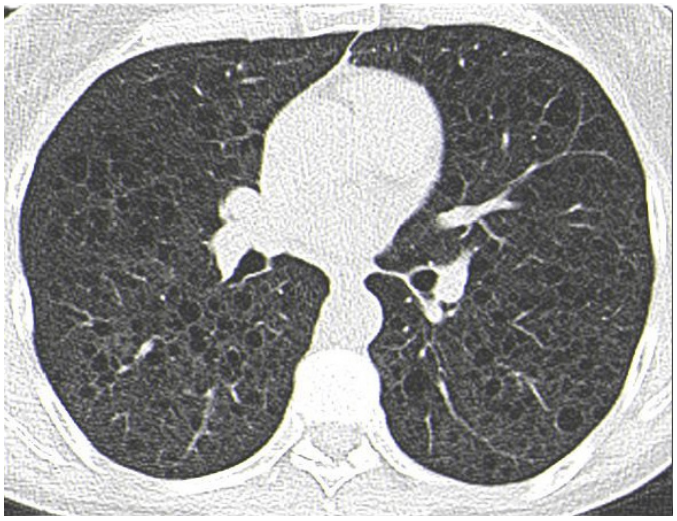


Figure 3. Low-dose computed tomography image of an additional finding - lymphangioleiomyomatosis in an asymptomatic screening participant.

Some findings are, strictly speaking, not true incidental findings but rather comorbidities that are particularly relevant to the screening population. Emphysema and chronic bronchitis are common among individuals who smoke, while coronary artery calcification is frequently visible on LDCT. These findings may have important clinical implications and should be reported appropriately (**Figure 2, Figure 3**).

An area of potential benefit is coronary artery calcium (CAC) assessment. Although definitive data regarding the effect of visual CAC scoring on mortality are still lacking, several studies have demonstrated clinically relevant associations and suggest potential benefit. The so-called big three – lung cancer, coronary artery calcification and emphysema – can all be identified on a single low-dose CT examination performed for lung cancer screening. Recognition of these conditions provides an opportunity to identify individuals at increased risk of both respiratory and cardiovascular disease and to initiate appropriate preventive or therapeutic interventions. Thus, the potential benefits of lung cancer screening may extend beyond early cancer detection and mortality reduction to the broader prevention and management of major smoking-related diseases (10).

The more challenging question concerns so-called true incidental findings. When should they be reported? What follow-up should be recommended? How should a potentially serious incidental finding be documented? What should the subsequent medical pathway be? And what should be done with findings that are unlikely to be clinically significant? These questions have not yet been incorporated into a sufficiently broad consensus. Importantly, this is not solely a medical issue; it also has legal and medico-legal implications regarding the responsibilities and expectations placed on radiologists and screening programmes.

Screening of low-risk individuals – people who never smoked

Lung cancer in never-smokers is among the leading causes of cancer mortality worldwide, and in some countries never-smokers account for more than 20% of all lung cancer cases. Critics of current screening strategies may therefore ask why screening programmes focus primarily on individuals who smoke and whether this disadvantages those who have maintained a healthy lifestyle.

The rationale for the current approach is that screening high-risk individuals who smoke is expected to detect a substantial proportion of lung cancers at an earlier stage, whereas screening the general never-smoking population has not yet been shown to provide a favourable balance of benefits and harms. Nevertheless, this issue highlights the importance of considering both the costs and benefits of lung cancer screening at the population level.

Risk stratification may further improve the efficiency of screening. Rather than relying solely on age and smoking history, contemporary approaches increasingly incorporate additional risk factors such as chronic obstructive pulmonary disease, body mass index, occupational exposures, and family history. In the future, the integration of validated risk prediction models with imaging biomarkers and blood-based biomarkers may allow screening to be targeted more precisely towards individuals at the highest risk.

There are substantial financial and logistical costs associated with lung cancer screening. Do healthcare systems have the resources to screen the entire population? What should the eligibility threshold be? At what age should screening begin, and how frequently should it be performed? Should never-smokers or individuals at lower risk also be screened? At the individual level, there is also a need to consider the potential harms of screening, including radiation exposure, false-positive findings, additional investigations, and the psychological burden associated with indeterminate findings. In current screening programmes, the lung cancer detection rate is approximately 1%. Thus, among 100 screened individuals, approximately 99 will undergo screening without a lung cancer diagnosis, while one individual may be identified with a cancer that could benefit from early detection. If never-smokers or individuals with a low smoking history were included, this ratio would decrease further (11). For this reason, considerable research is currently focused on identifying biomarkers that can help identify individuals at increased risk of lung cancer. Several existing screening programmes, such as the UK Lung Cancer Screening Programme and the Canadian approach, already use risk calculators that incorporate factors beyond age and smoking history, including body mass index, chronic obstructive pulmonary disease, and occupational history. Other biomarkers may be blood-based; for example, promising research from Italy is investigating small microRNA fragments (12). Hopefully, in the coming years, a clinically validated panel of biomarkers will be developed, allowing us to identify individuals at increased risk who may benefit from screening even in the absence of a significant smoking history.

Lung cancer screening worldwide

These questions are particularly relevant to high-income countries, where most of the evidence supporting lung cancer screening has been generated. Whether these findings can be directly translated to low- and middle-income countries (LMICs) remains an important unanswered question, given substantial differences in smoking patterns, healthcare infrastructure, available resources, and access to diagnostic and treatment services. The success of a screening programme depends not only on the diagnostic performance LDCT, but also on whether the healthcare system has the capacity to deliver the entire screening pathway effectively, equitably, and sustainably.

Health system capacity is a key consideration when assessing the feasibility of lung cancer screening in LMICs. Limited

availability of CT scanners, uneven geographical distribution of imaging services, shortages of radiologists and other trained healthcare professionals, and restricted access to diagnostic procedures can create substantial barriers to implementation. Fragmented referral systems and limited capacity for timely follow-up may result in delays between identification of a pulmonary nodule, diagnostic confirmation, and initiation of treatment. These challenges are particularly important because the effectiveness of screening depends not only on detecting cancer at an earlier stage but also on ensuring that individuals with abnormal findings can undergo appropriate diagnostic evaluation and receive timely, potentially curative treatment.

Lung cancer risk profiles in LMICs also vary considerably between populations and regions. Although tobacco smoking remains an important risk factor, other exposures may contribute significantly to disease burden. Household air pollution, occupational exposure to carcinogens, outdoor air pollution, chronic respiratory diseases, previous pulmonary infections, and other locally prevalent environmental risk factors may influence lung cancer risk. Differences in smoking patterns, population demographics, comorbidities, and healthcare-seeking behaviour may further affect the applicability of screening eligibility criteria developed in high-income countries. Consequently, screening strategies developed in high-resource settings may require adaptation before they can be effectively implemented in LMIC populations.

Real-world evidence on lung cancer screening implementation in LMICs remains limited. Published studies often originate from individual institutions or small pilot programmes and may not comprehensively assess healthcare infrastructure, implementation barriers, costs, follow-up pathways, or downstream patient outcomes. As LMICs increasingly consider strategies for earlier lung cancer detection, there is a need for evidence that moves beyond the efficacy demonstrated in clinical trials and addresses the realities of implementation in resource-constrained settings. Studies must be conducted to understand health system readiness, affordability, sustainability, and equity to develop lung cancer screening approaches that are appropriate for LMIC populations and capable of delivering meaningful improvements in early diagnosis and outcomes.

Conclusions

Finally, successful implementation requires continuous monitoring and quality assurance. Programmes should evaluate not only the number of examinations performed, but also participation rates, adherence to subsequent screening rounds, stage distribution at diagnosis, false-positive rates, complications from diagnostic procedures, treatment access, and ultimately lung cancer mortality. Particular attention should be paid to disparities between socioeconomic and demographic groups.

The ultimate objective of lung cancer screening should therefore not simply be to establish a technically successful CT screening programme. It should be to create an accessible, equitable, and sustainable pathway that identifies high-risk individuals, detects cancer at an earlier and more treatable stage, and ensures that patients can progress rapidly from screening to diagnosis and appropriate treatment. Only when these elements are integrated can the mortality benefits demonstrated in clinical trials be translated into meaningful population-level benefits in the real world. The question is no longer only whether lung cancer screening can detect disease earlier, but how rapidly and effectively we can translate this evidence into practice. Implementation will require coordinated preparation across healthcare systems, from identifying eligible populations and ensuring access to high-quality low-dose CT to establishing diagnostic and treatment pathways capable of responding to screen-detected disease. This work should begin now. Careful organisation and preparation today are essential if we are to realize the mortality reduction that lung cancer screening has the potential to deliver.

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