Self-Selection in Randomized Controlled Trials and Screening Decisions: Evidence from the Screening Trial for Lung Cancer (NLST-845)

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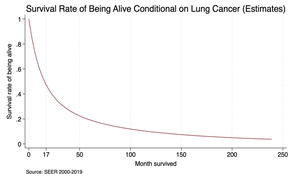
Background & Objective

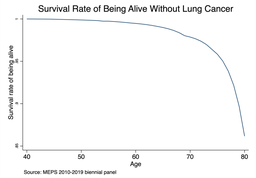
- Lung cancer is the leading cause of cancer-related death in the U.S. and worldwide.
- LDCT (Low-dose computed tomography) screening can detect cancer earlier, but real-world uptake remains low despite guideline expansions. For example, only 4.5% eligible individuals are screened in 2022. (Eligibility: high-risk individuals with 30+ pack-year smoking history)
- The core problem is self-selection: preventive screening may attract proactive, healthier people instead of only the highest-risk people.
- If screening resources do not reach the right group, mortality benefits and spending efficiency are both reduced.
- Understand the self-selection in preventive screening is the key in improving screening uptakes among high-risk individuals and designing more cost-effective healthcare guidelines.

Objective: Develop a dynamic discrete-choice model to understand how self-selection affect lung cancer screening uptakes, thereby influencing the health outcomes and healthcare costs.

Data and Lung Cancer Survivals

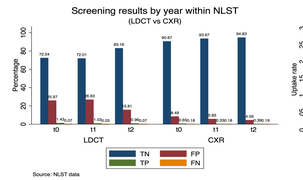
- NLST trial data: 52,318 participants after sample selection; high-risk smokers assigned to LDCT or CXR (chest X-ray) and followed for screening results, diagnosis, treatment, and survival.
- NHIS 2015 population data: 19,386 individuals after sample selection; provides lung cancer screening decisions outside the trial.
- SEER 2000–2019: population cancer registry used to estimate survival conditional on lung cancer with 584k+ individuals in the sample.
- MEPS 2010–2019: complementary source for lung cancer incidence / baseline risk.

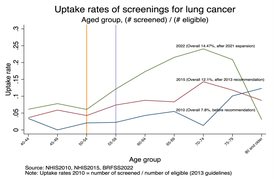




Institutional Context and Screening Guidelines

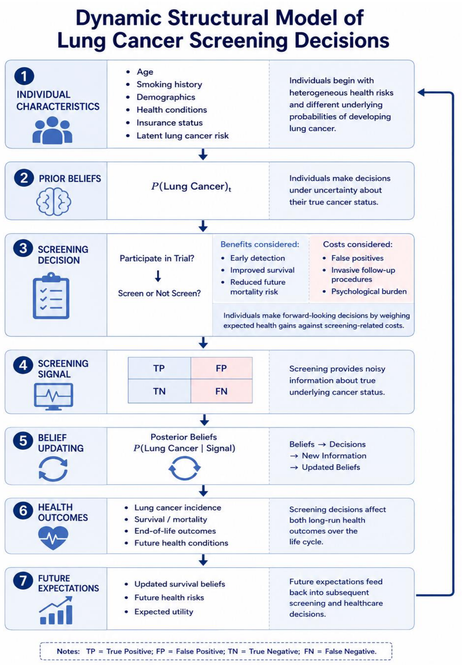
- NLST compared LDCT with CXR among high-risk smokers, with participants being randomly assigned to do annual screenings under either LDCT or CXR for 3 years.
- LDCT improves early detection but creates more false-positive results while CXR is unable to detect < 4mm tumor but with lower false-positive rates.
- Guidelines expansion: 2013 USPSTF, 2021 USPSTF expansion, 2023 ACS expansion.





Model: Dynamic Discrete-Choice Model of Lung Cancer Screening and Lung Cancer Trial Participation

- Dynamic discrete-choice model: each year, individuals choose whether to screen; trial participants also choose whether to remain in the trial.
- People are forward-looking: today's screening affects beliefs, future screening, survival, and costs.



Estimation Method: Weighted Exogenous Maximum Likelihood

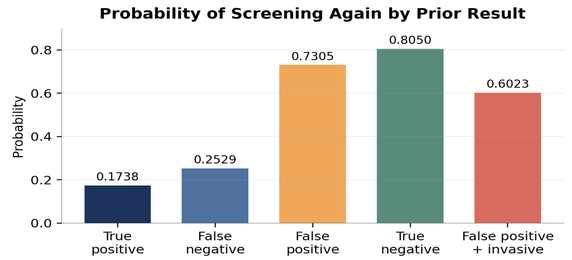
- Estimate a model of two linked decisions: trial participation and lung cancer screening.
- Use trial data to observe detailed screening results and population data to avoid relying only on selected trial participants.
- Correct the choice-based NLST sample using a weighted exogenous maximum likelihood approach; estimate remaining parameters by maximum simulated likelihood.
- Use the estimated model to run counterfactual "what-if" simulations of alternative screening recommendations.

What the Model Adds

- Separates clinical risk from willingness to screen.
- Accounts for false-positive and false-negative uncertainty.
- Allows past screening results to affect future adherence.
- Makes it possible to compare policy targets when 100% uptake is unrealistic.

Result 1: Screening Experience Matters

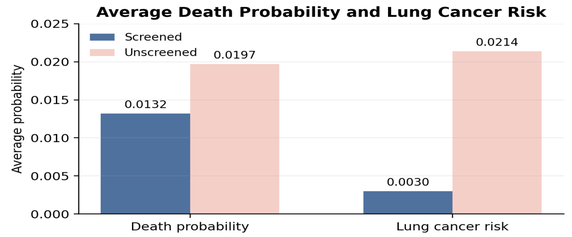
False positives alone do not stop screening, but invasive follow-up lowers repeat screening.



- Biopsies/invasive follow-up reduce continued screening probability by roughly 10%.

Result 2: Evidence of Self-Selection

Screened individuals are lower-risk than unscreened individuals in the estimated population fit.



- Screening uptake reflects both health risk and unobserved preference for health investment.

Additional Results

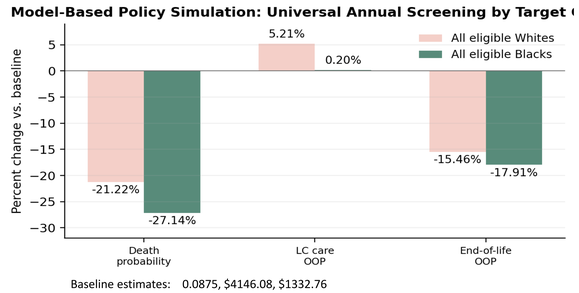
- People are more likely to screen as the time since last screening increases (positive duration dependence).
- Among lung cancer patients, individuals who screen tend to hold higher prior beliefs of lung cancer risk.
- Limited expected survival benefits can rationalize low uptake even when screening is clinically recommended.
- False-positive uncertainty matters because it creates anxiety, diagnostic procedures, and future adherence costs.
- Screening decisions can be rationally low if patients perceive low survival gains from early detection.

Main takeaway

Low uptake is not only an access problem. It is also a behavioral selection problem: the people who choose screening are not necessarily those who would benefit most.

Counterfactual Analysis: Whom to Recommend?

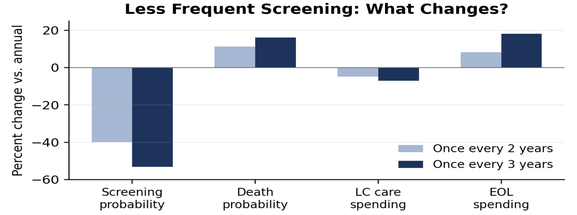
Simulate full annual screening among target groups while others behave as estimated.



- Targeting all eligible Black individuals: death probability falls by 27.14% with only 0.20% increase in Medicare lung cancer care OOP.
- This suggests targeting underrepresented high-risk groups may be more cost-effective than broad untargeted outreach.

Counterfactual Analysis: How Often to Screen?

Less frequent screening saves some care spending but raises mortality and end-of-life spending.



Policy Implications

- Guidelines should not only expand eligibility; they should improve targeting and adherence among high-risk underrepresented groups.
- Patient experience after false positives matters for long-run screening participation.
- Annual screening remains the most life-saving recommendation among simulated screening frequencies.
- A practical policy lens: target, explain, and follow up—not only expand eligibility.

Limitations & Extensions

- Treatment choices, false-positive rates, and invasive procedures are not fully endogenized.
- Future work: incorporate richer clinical oncology progression and treatment pathways.
- Spending estimates are simulation inputs, not claims-based causal effects.

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