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Cost-effectiveness of lung cancer screening strategies in China: Markov model and discrete event simulation comparison

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Abstract: Lung cancer screening using low dose computed tomography (LDCT) has demonstrated potential in reducing mortality in high-risk populations through early detection (National-Lung-Screening-Trial-Research-Team, 2011). Recent studies suggest that Polygenic Risk Scores (PRS) could further enhance screening efficiency (Klein & Gümüş, 2022). However, the choice of modelling techniques in health economic evaluations can significantly impact the estimated cost-effectiveness of these screening programs.

This study aims to compare the use of Discrete Event Simulation (DES) with the previously published Markov model in evaluating the cost-effectiveness of lung cancer screening strategies for high-risk populations in China, incorporating both LDCT and PRS, with a focus on their ability to accurately model mortality outcomes.

We developed a DES model to evaluate lung cancer screening strategies for high-risk individuals in China, replicating the structure and clinical effectiveness data of the previously published Markov model by Zhao et al (Zhao et al., 2024). The models were populated with identical clinical effectiveness, health utility, and cost data for LDCT and PRS-based screening but differed in their structural approach to modelling disease progression and mortality in high-risk populations.

The DES model demonstrated superior capability in capturing the complex, time-dependent nature of lung cancer progression and the impact of early detection on mortality in high-risk groups. Unlike the Markov model, which relied on simplified annual transition probabilities, the DES model utilised time-to-event parameters, allowing for more accurate representation of survival outcomes. This led to notable differences in the estimated cost-effectiveness of LDCT and PRS-based screening strategies for high-risk populations between the two modelling approaches.

Our findings suggest that DES offers a more nuanced and potentially more accurate method for modelling lung cancer screening programs targeting high-risk populations, incorporating LDCT and PRS, particularly in capturing long-term mortality benefits. The Markov model's necessity to convert survival outcomes from time-to-event data to annual transition probabilities compromises its ability to reflect the survival analysis outcomes of disease progression and screening impact in high-risk groups. These results have important implications for health economic analyses and policy decisions regarding the integration of PRS into LDCT-based lung cancer screening programs for high-risk populations in China.

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