



21st

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WARSAW INTERNATIONAL MEDICAL CONGRESS

ABSTRACT

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Hybrid Session

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Chest X-Ray–Predicted Age as a Biomarker for Short- and Long-Term Mortality: Development and Validation of a Deep Learning Model

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Introduction

Chronological age is an imperfect measure of physiological health. Biological age, estimated from medical imaging may better capture an individual's true health status and risk. This study aimed to develop a deep learning model to estimate a patient's age from a chest radiograph (CXR) and to evaluate whether the discrepancy between this "CXR-age" and chronological age—the "CXR-age gap"—predicts all-cause mortality.

Aim of the study

To develop and externally validate a robust deep learning model capable of estimating biological age from chest radiographs (CXR) across diverse, multi-source datasets, and to investigate whether the derived CXR-age gap (difference between predicted imaging-based age and chronological age) serves as an independent and clinically meaningful biomarker of physiological aging that can predict short- and long-term all-cause mortality and improve risk stratification beyond traditional clinical and demographic risk factors.

Materials and methods

This retrospective multi-cohort study included 404,812 frontal CXRs from MIMIC-CXR, CheXpert Plus, PadChest, RexGradient, and CASIA CXR. A DenseNet-121 model was trained (80%) and tested (20%) to predict age, with a dual-input design including demographic variables. Performance was evaluated using MAE and Pearson r . Associations between CXR-age gap and 30-day, 90-day, and 1-year mortality were analyzed using multivariable logistic regression and Cox models adjusted for clinical covariates.

Results

The model predicted chronological age with a mean absolute error of 3.6 years and a Pearson correlation of $r = 0.85$ in the test set. The mean CXR-age gap was -0.2 years (SD 4.6). After adjustment, each 5-year increase in the CXR-age gap was associated with higher odds of mortality at 30 days (aOR 1.22, 95% CI 1.19–1.25) and 90 days (aOR 1.25, 95% CI 1.22–1.28), and a higher hazard of mortality at 1 year (aHR 1.18, 95% CI 1.16–1.20). Adding the CXR-age gap to a baseline clinical model improved discrimination for 1-year mortality (AUC 0.79 to 0.83). Saliency maps highlighted the heart, mediastinum, and pulmonary vasculature as key regions contributing to predictions.

Conclusions

Deep learning can estimate age from chest radiographs with good accuracy across large, multi-source datasets. The CXR-age gap is an independent predictor of short- and long-term mortality and provides incremental prognostic value beyond traditional clinical risk factors. This accessible imaging biomarker may support improved risk stratification and clinical decision-making.

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