DOI: doi.org/10.47363/JAICC/ICAICC/2025(4)33

International Conference on
Artificial Intelligence and Cloud Computing (ICAICC-2025)

Conference Proceedings May 10, 2025 (Virtual)

AI-Driven Prediction of Cardiovascular Events: A Functional Data Analysis Approach for Clinical Decision Support

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Cardiovascular Diseases (CVD) remain the leading cause of mortality globally, necessitating advanced risk stratification methods to enhance early detection and prevention. This study applies machine learning techniques to functional data analysis, integrating anthropometric parameters, serum lipoprotein profiles, and blood pressure measurements to develop a personalized diagnostic model for cardiovascular event prediction. A cross-sectional study was conducted on 2,131 volunteers (mean age: 45.75 ± 11.7 years), analyzing their biochemical and clinical parameters. Multivariate data selection and classification techniques identified significant predictors of CVD, with a particular focus on the Atherogenic Index of Plasma (AIP), total Cholesterol (CH), and Low-Density Lipoproteins (LDL). Machine learning models trained on these data achieved a prediction accuracy exceeding 89%, with a model confidence level of 90% for individual risk assessments. The findings underscore the role of AI-driven personalized diagnostics in CVD risk assessment and stratification, particularly in differentiating risk profiles based on age and sex. The study highlights that AIP, CH, and LDL serve as primary biomarkers for hypertension and cardiovascular risk, with stronger correlations observed in older populations. The integration of AI and cloud-based predictive analytics offers a scalable and effective approach for real-time risk assessment, potentially improving clinical decision-making and preventive strategies. Medical application development perspective. The study lays the foundation for developing AI-powered clinical decision support systems capable of integrating real-time patient data with predictive analytics. Such applications could enable: - Early identification of high-risk patients based on routine laboratory tests and clinical parameters. - Automated risk scoring and decision-making support for physicians in primary care and specialized cardiology settings. - Cloud-based AI platforms for remote patient monitoring and personalized treatment recommendations using adaptive algorithms. - Integration into electronic health records to enhance clinical workflow efficiency and improve patient outcomes. These results demonstrate the feasibility of AI-enhanced functional data analysis in identifying high-risk individuals and advancing data-driven interventions in cardiovascular healthcare. Future research will focus on developing a prototype AI-powered application that can be validated in clinical settings for real-world implementation and widespread adoption.

Keywords: artificial intelligence, machine learning, cardiovascular disease prediction, functional data analysis, clinical decision support, digital health, personalized diagnosis, healthcare AI, risk stratification, cloud-based health monitoring.