Development of a multimodal AI framework for precision cardiovascular risk prediction

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Cardiovascular disease (CVD) affects around 14% of adults and is a major global cause of death. It includes conditions such as coronary artery disease (CAD), myocardial infarction, heart failure and stroke, all of which place a substantial burden on healthcare systems. Managing modifiable risk factors (e.g. diet, exercise, smoking) together with early identification of genetic susceptibility (CAD heritability ~40–50%) is crucial, particularly for higher-risk groups such as South Asians.
Current CVD risk tools (QRISK3, SCORE2, PCE) rely on conventional factors and may not fully capture the broader atherogenic profile. Recent work shows that genetic predisposition, summarised through Polygenic Risk Scores (PRS), significantly influences CAD risk. Individuals in the top 10% of CAD-PRS have risk comparable to monogenic conditions like familial hypercholesterolaemia, but predictive power declines outside this group. There is therefore a clear need for AI-driven, multi-modal risk prediction tools that perform reliably across diverse populations.
We have developed an innovative AI-framework, that integrates multi-omics, lifestyle and clinical CVD risk for British South-Asians, with transferability to other ancestral populations. We have leveraged transcriptomic and proteomic data obtained from CVD-free British South Asians, selected from the lower (<10%), middle (45-55%) and upper (>90) deciles of the CAD multi-ancestry PRS distribution of a 52,000 participant-cohort. Employing state-of-the-art Machine Learning (ML) models and AI algorithms, we integrated the PRS with transcriptome signatures, proteomics data, clinical factors, and lifestyle information (diet, smoking, alcohol consumption, physical activity). This comprehensive approach aims to develop a high-precision prediction tool for CVD that outperforms existing models in performance and reliability. We will validate this tool externally in a subset of Middle East ancestry individuals (Qatari Biobank) and other multi-modal worldwide datasets.
This study represents an innovative effort to bridge the existing gap in cardiovascular risk prediction tools by combining clinical, biochemical, multi-omics and lifestyle information through AI implementations.