A model of lifetime health outcomes in cardiovascular disease based on clinical trials and large cohorts

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Background and purpose: Cardiovascular disease (CVD) risk of individuals depends on their socio-demographic characteristics, clinical risk factors, and treatments, and strongly influences their quality of life and survival. Individual-based long-term disease models, which aim to more accurately calculate the lifetime consequences, can help to target treatments, develop disease management programmes, and assess the value of new therapies. We present a new micro-simulation CVD model.

Methods: This micro-simulation model was developed using individual participant data from the Cholesterol Treatment Trialists' collaboration (CTT: 118,000 participants; 15 trials) and calibrated (with added socioeconomic deprivation, ethnicity, physical activity, mental illness, cancer and incident diabetes) in the UK Biobank cohort (UKB: 502,000 participants). Parametric survival models estimated risks of key endpoints (myocardial infarction (MI), stroke, coronary revascularisation (CRV), diabetes, cancer and vascular (VD) and nonvascular death (NVD) using participants' age, sex, ethnicity, physical activity, socioeconomic deprivation, smoking history, lipids, blood pressure, creatinine, previous cardiovascular diseases, diabetes, mental illness and cancer at entry and non-fatal incidents of the key endpoints during follow-up. The model integrates the risk equations and enables annual projection of endpoints and survival over individuals' lifetimes. The model was used to project remaining life expectancy across UK Biobank participants.

Results: Nonfatal cardiovascular events and age were the major determinants of CVD risk and, together with incident diabetes and cancer, of individuals' survival. The cumulative incidence of the key endpoints predicted by the CTT-UKB model corresponded well to their observed incidence in the UK Biobank cohort, overall (Figure 1) and in categories of participants by age, sex, prior CVD and CVD risk. Predicted remaining life expectancy across UK Biobank participants without history of CVD ranged between 22 and 43 years in men and between 24 and 46 years in women, depending on their age and CVD risk (Figure 2). Among UK Biobank participants with history of CVD, depending on their age, predicted remaining life expectancy ranged from 20 to 32 years in men and from 26 to 38 years in women.

Conclusion: This new lifetime CVD model accurately predicts morbidity and mortality in a large UK population cohort. It will be made available to provide individualised projections of expected lifetime health outcomes and benefits of treatments.

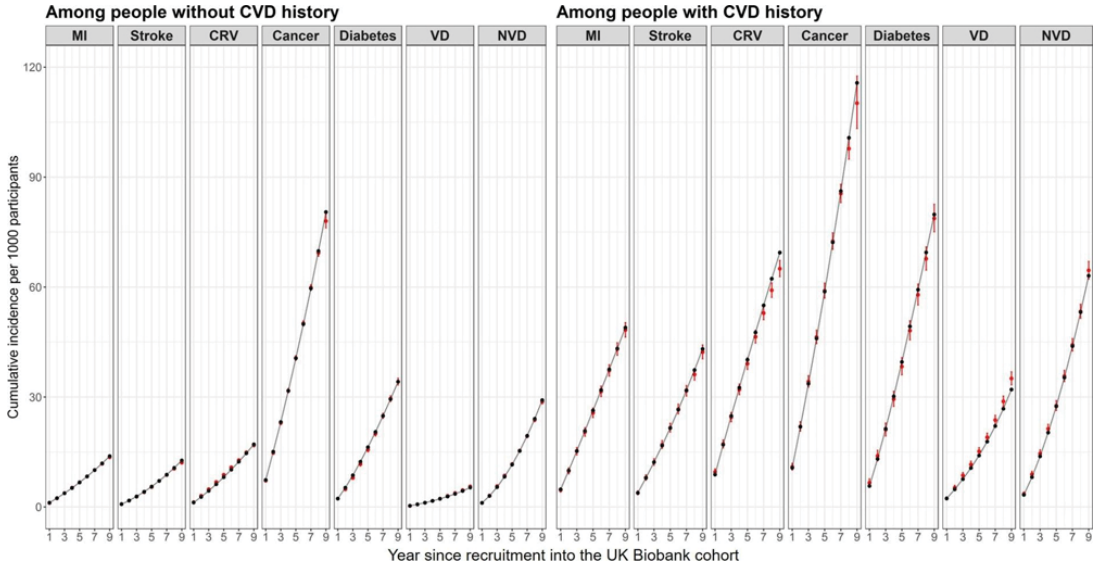

Figure 1. Predicted (in black) versus observed (95% CI; in red) incidence of major clinical outcomes in the UK Biobank.

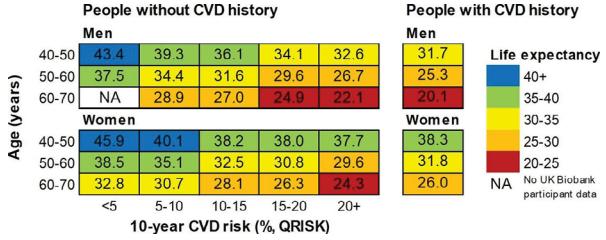

Figure 2. Predicted remaining life expectancy of participants in UK Biobank cohort, by age and CVD risk or previous CVD at entry. QRISK, a 10-year CVD risk scoring algorithm for people without previous CVD, recommended for use in the UK National Health Service.