Machine Learning-Based Prediction of Cardiovascular Disease Risk

A 5-Year Forecast Using 22 Million Data Points from Nordic Countries and France

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Introduction

This study is one of the five use cases selected by the **European Health Data Space (EHDS)** pilot program, serving research, innovation, policy-making and regulatory purposes.

The EHDS is a regulatory framework designed to standardize health data use in the European Union by establishing a cross-border infrastructure and secure, collaborative ecosystem.

Objective: Compare cumulative incidence and estimate **cardiovascular disease (CVD) risk** using machine learning models across France, Denmark, Finland, and Norway.

Methods

Data Collection

- **22 million individuals** aged 18-85 years
- National health registries data: 2010-2018
- **4 countries**: France, Denmark, Finland, Norway

CVD Events Analyzed

- Ischemic heart disease
- Myocardial infarction
- Angina pectoris
- Ischemic stroke

Machine Learning Model

Gradient Boosted Decision Tree (GBDT) trained on all diagnoses and medication records to predict 5-year CVD risk (2014-2018)

Cohort Characteristics

France
n = 11,744,558
Female: 53.9%
Mean age: 46.95 ± 17.32

Finland
n = 4,145,551
Female: 50.9%
Mean age: 48.5 ± 17.6

Denmark
n = 4,180,434
Female: 50.6%
Mean age: 47.42 ± 17.24

Norway
n = 3,636,535
Female: 49.9%
Mean age: 46.74 ± 17.23

References

1. European Commission. Communication from the commission - a european health data space: harnessing the power of health data for people, patients and innovation. COM(2022) 196/2.
2. Ganna A, et al. The European Health Data Space can be a boost for research beyond borders. Nat Med. 2024;30(11):3053-3056.

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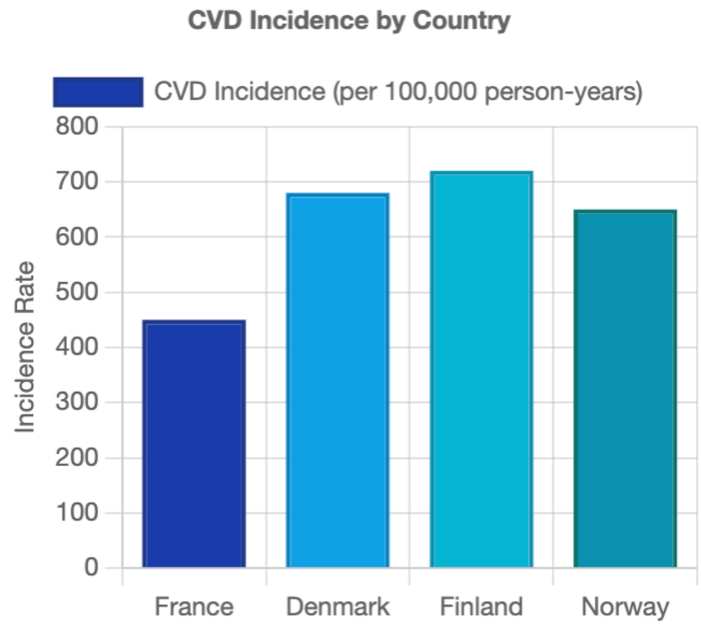
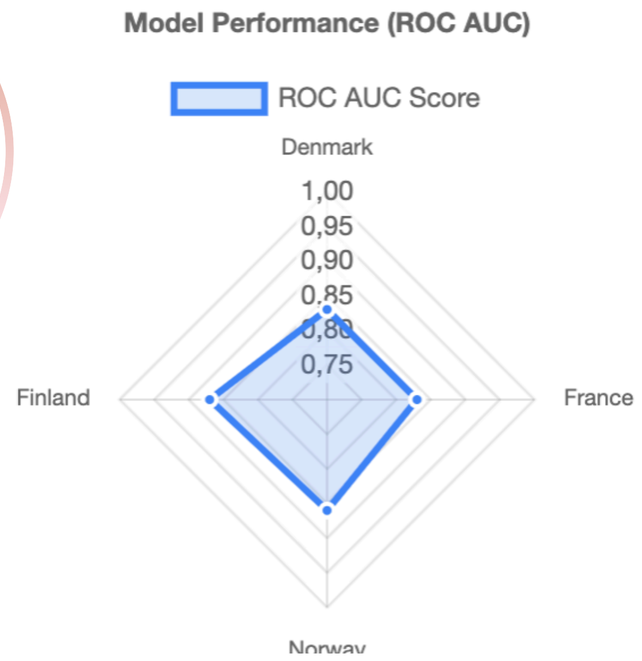
Results

CVD Incidence Comparison



France shows significantly lower CVD incidence rates compared to Nordic countries, indicating better CVD prevention, lifestyle, and health services.

GBDT Model Performance



ROC AUC Scores
Denmark: 0.83 |
France: 0.83
Norway: 0.86 |
Finland: 0.87

Brier Scores
France: 0.02 |
Finland: 0.04
Norway: 0.04 |
Denmark: 0.07

Conclusions

This study provides preliminary understanding of cross-country comparability, guiding future research and targeted investigations.

Key Findings

Comparable Model Performance: GBDT achieved similar accuracy across all countries (ROC AUC: 0.83-0.87)

Regional Differences: France showed significantly lower CVD incidence rates

Future Research Directions

- Incorporate time-varying covariates for medication usage
- Address data imbalance using sampling techniques
- Enhance cross-border health data sharing initiatives