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AN UPDATE ON REAL-TIME APPLICATION OF MACHINE LEARNING PROGRAMS TO IMPROVE CARDIOVASCULAR RISK PREDICTION IN EUROPEAN POPULATION

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Background

- According to European Cardiovascular Disease Statistics 2019, Cardiovascular disease (CVD) is responsible for **~3.9 million deaths in Europe** each year [1].
- CVD places a **substantial financial burden** on the health care systems in Europe [2].
- Current approaches for CVD risk prediction include tools such as Cardiovascular Risk Score (QRISK2) , Framingham , Reynolds etc. [3][4].
- However, these **fail to identify individuals at CVD risk**, while others receive unnecessary intervention [3][4].
- Artificial intelligence/machine learning (**AI/ML**) represents a powerful framework to **recognise complex patterns** in large-scale clinical data with the potential to **improve risk prediction** [3].
- Recently, AI/ML has **shown promise in CVD risk prediction** [3] and offers a unique opportunity to improve accuracy by exploiting complex interactions between CVD risk factors (Figure 1) [3][4].
- Based on the patient data available, there are currently **four types of ML algorithms**: supervised, semi-supervised, unsupervised and reinforcement [4].

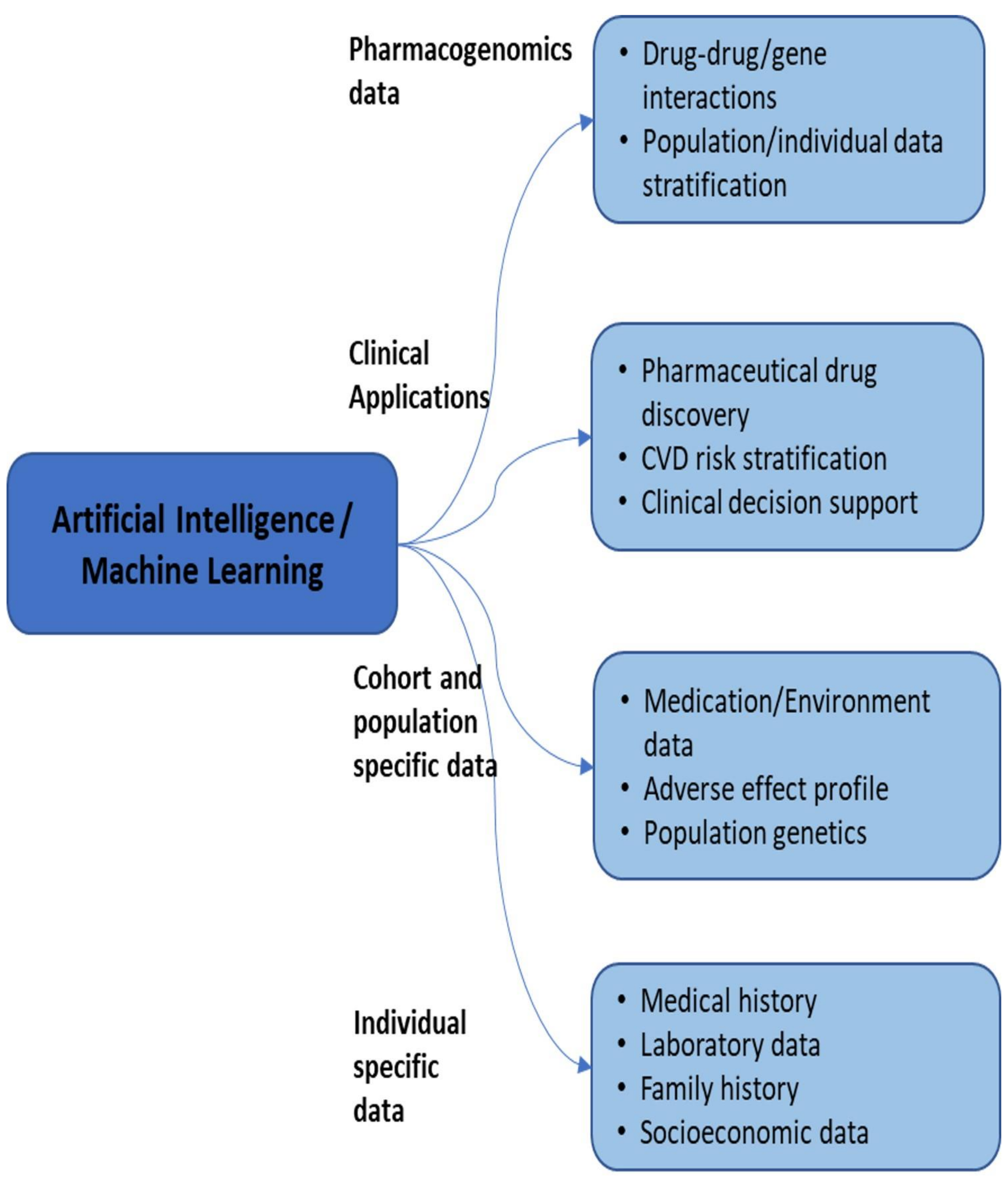

Figure-1: Key role of AI/ML in cardiovascular medicine and research [5]

Objective

The study aimed to :

- Summarise the composite predictive ability of AI/ML algorithms to improve CVD risk prediction in focused populations.
- Determine the most common CVD risk factors by the various ML algorithm.

Methods

Database Search

- PubMed, EMBASE, and Cochrane were searched from 2018 to 2022 to identify the most recent literature reporting the use of AI/ML in predicting CVD risk analysis (Figure 2).
- A total of **50** articles published in English were selected, focusing on geography and algorithms employed.
- **6** studies were further excluded from the analysis due to unavailability of sufficient data.

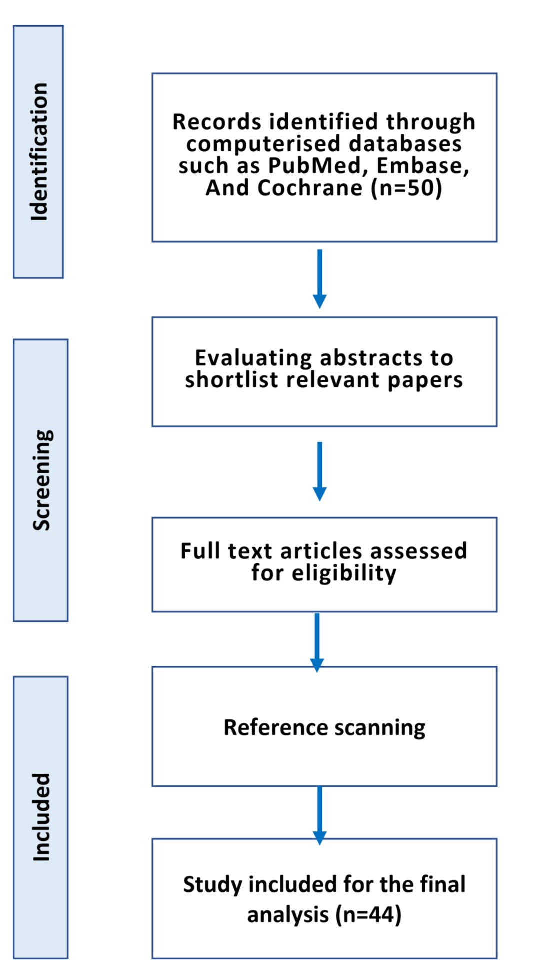

Figure-2: Database Search Strategy

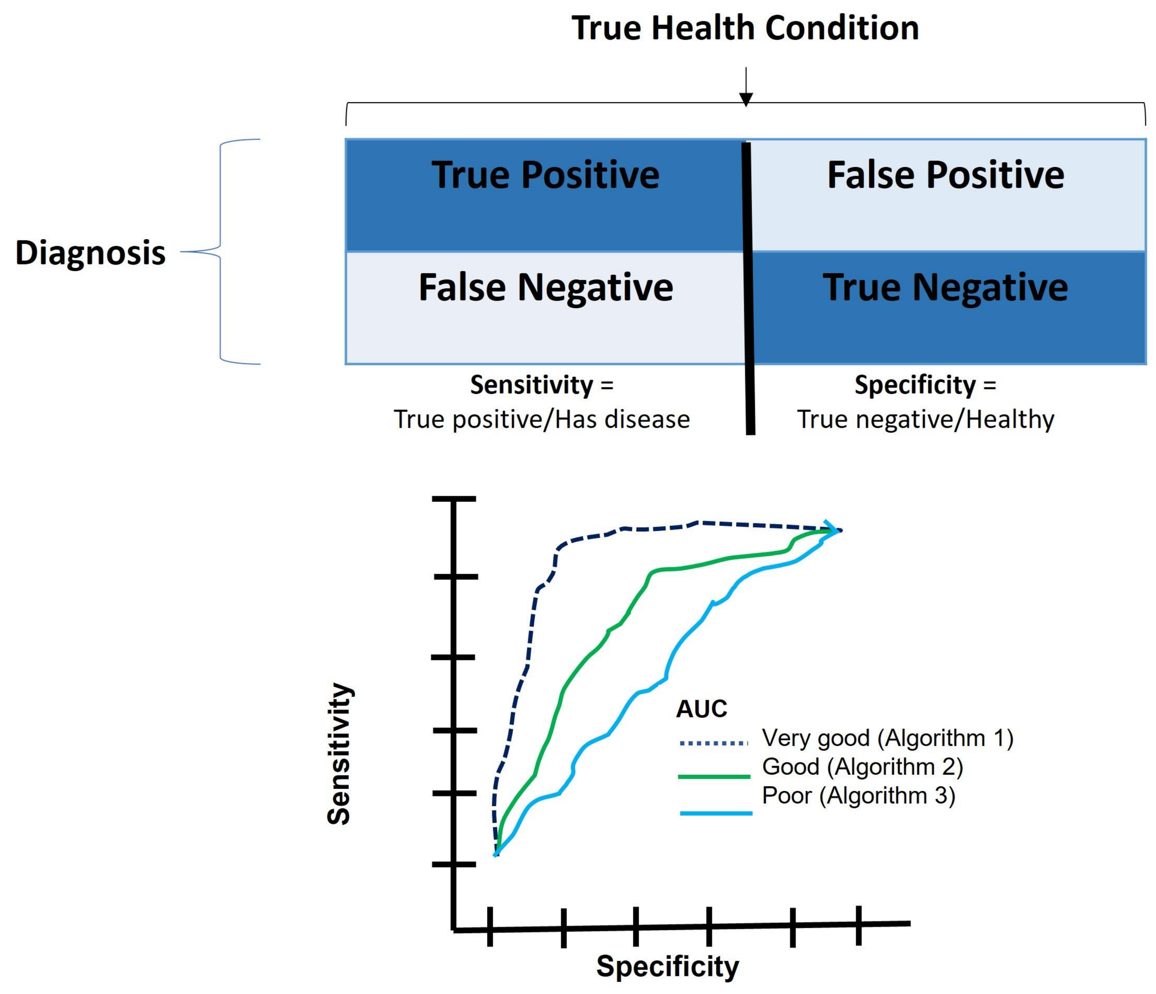

Figure-3: Calculation of AUROC [6][7]

- The area under the receiver operating characteristic curve (**AUCROC**) was used to quantify the improvement over random chance (**AUCROC: 0.5**).
- AUC summarizes the overall **diagnostic accuracy** of the test.
- It takes values from 0 to 1, where a value of 0 indicates a perfectly inaccurate test and a value of 1 reflects a perfectly accurate test [6].
- Sensitivity or true positive rate measures the ability of a model to correctly identify positive examples.
- Specificity measures the proportion of true negatives that are correctly identified by the model [6](Figure 3).

Sensitivity = (True Positive)/(True Positive + False Negative)

Specificity = (True Negative)/(True Negative + False Positive)

Results

- In the included studies, a total of **2,620,577** individuals were analysed. The study findings are elaborated in Table 1.

Table 1: Study findings (n=44)

Characteristics	*n* (%)
Study design	
Observational	18 (41 %)
Experimental	26 (59 %)
Year of publication	
2017	5 (11%)
2018	4 (9%)
2019	9 (21%)
2020	5 (11%)
2021	13 (30%)
2022	8 (18%)
Nation	
Europe	**44 (100%)**
Total sample size	**2,620,577**
Sample size	
<100	5 (11%)
101–1000	11 (25%)
1001–10,000	14 (32%)
10,001–100,000	6 (14%)
>100,000	8 (18%)
Machine Learning Categories	
Supervised	39 (87%)
Unsupervised	3 (8%)
Semi-supervised	2(5%)

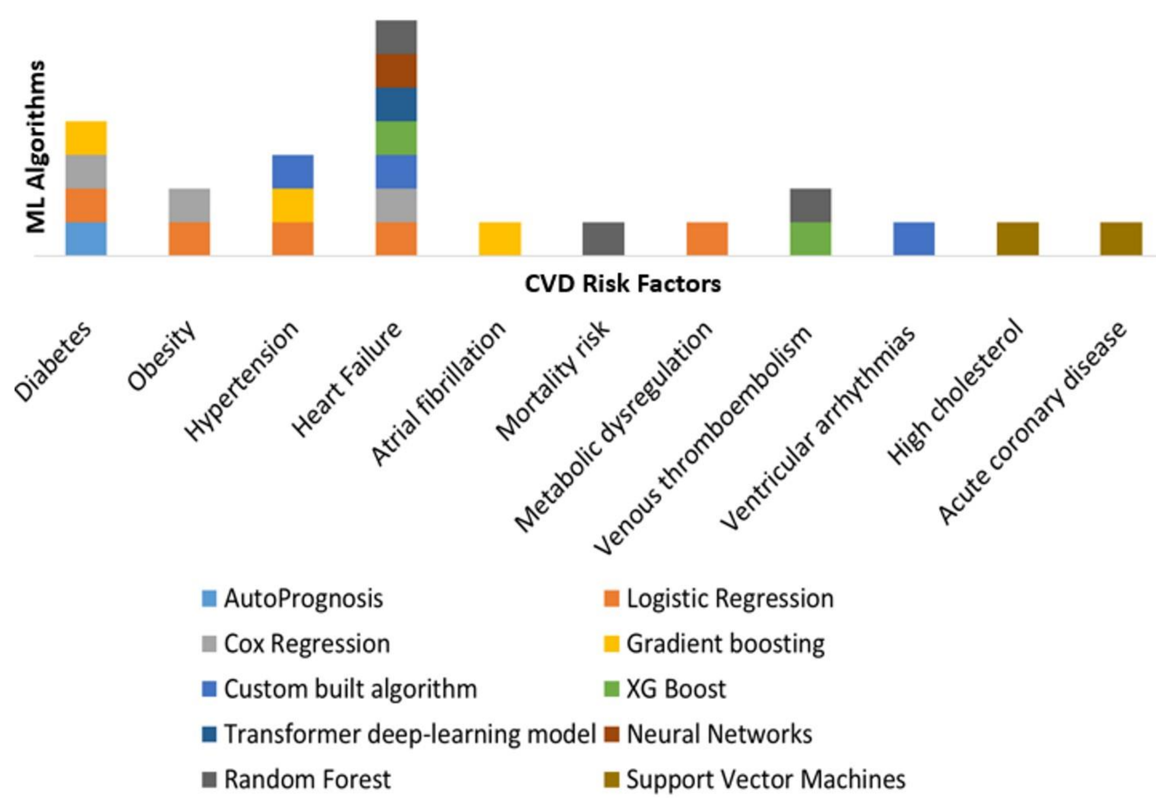

Figure 4: ML algorithms used in prediction of CVD risk factors.

- ML algorithms identified **diabetes, obesity, heart failure (HF)** and **hypertension** as key CVD risk factors [8-13] (Figure 4).
- For prediction of **diabetes**, AutoPrognosis, logistic regression (LR), cox regression (CR) and gradient boosting (GB) models had a pooled **AUCROC of 0.71, 0.82, 0.73 and 0.68**, respectively [8][9](Figure 5).
- For prediction of **obesity**, LR and CR models had a pooled **AUCROC of 0.75 and 0.82** [10](Figure 5).
- For prediction of **HF** and **hypertension**, LR, GB, and custom-built models had a pooled **AUCROC of 0.73, 0.80, and 0.89**, respectively [9][11](Figure 5).
- Notably, **CVD-related hospitalisation and mortality risk** was also accurately predicted by RF and AdaBoost models (**AUCROC: 0.83, 0.78**), respectively [12][13](Figure 5).

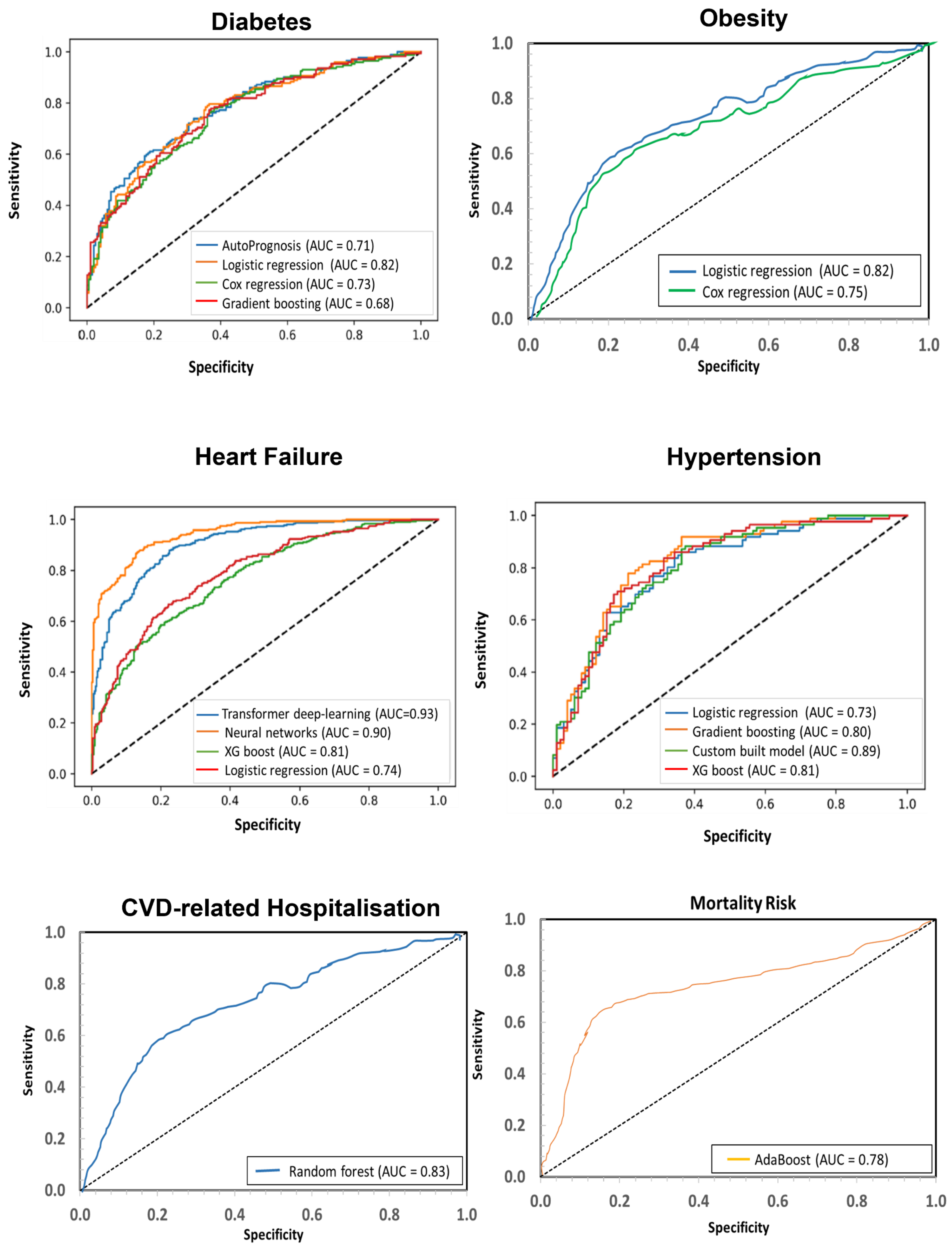

Figure-5: ROC curves for the prediction of CVD risk factors using various ML algorithms.

Conclusion

- Our targeted review summarises that **AI/ML models may accurately predict CVD risk factors** in European populations.
- AI/ML techniques can be **useful for early identification of high-risk individuals for developing CVD**.
- This can guide **clinicians/policy makers to make informed decisions** regarding early therapeutic interventions, thereby reducing CVD risk burden.
- However, more **research is warranted to evaluate other CVD-related risk factors** and to also include ML as a part of large population-based CVD risk assessment tools and databases.

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