CONTENT NOTE:

This document includes discussion of maternal mental health, including experiences of emotional distress during or after pregnancy. We recognise that some member of the audience may have lived exprience of these issues. Please take care while viewing, and feel free to step away, or speak to someone for support if needed. If you are affected by any of the topics raised, support is available through organisations such as:

- Samaritans, call 116 123 (free, 24/7);
- Mind, call 0300 123 3393 www.mind.org.uk;
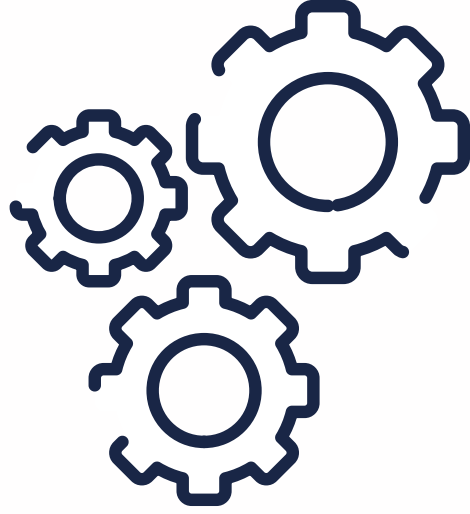- Birth Trauma Association, www.birthtraumaassociation.org.uk

ADVANCING PREDICTIVE PATHWAYS FOR MATERNAL MENTAL HEALTH RECOVERY: MACHINE LEARNING, MODEL INTEGRATION, AND SCALABLE DEPLOYMENT OF RECOVERY TRAJECTORIES

N8 CIR
COMPUTATIONALLY INTENSIVE RESEARCH

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BACKGROUND

In what ways can machine learning can be leveraged to explore patterns, predictors and classification in maternal mental health outcomes?

- Perinatal mental health problems affect 27% of new and expectant mothers.
- Left untreated, these conditions can have lasting effects.
- Fewer women in the north access treatment.

- Machine learning can support risk prediction.
  - Can capture complex relationships in data.
  - Can handle analysis of multidimensional data.

DATA AND METHODS

The dataset used in the project was synthetic.

- Dataset 102k and 152 features.
- Features based on Mental Health Services Data Set.
- Challenging to capture real-world nuance.
- Synthetic avoids regulatory restrictions and re-identification.

Target: EPDS category (≥13 = flagged as 1/high risk)

- Data was cleaned and prepared:
  - Imputed or replaced missing values.
  - Removed data outside NENC.
- Ordinal, label and target encoding.
- Cyclical encoding for dates.

- EDA: spatial and socioeconomic patterns (rural inland/coastal)
  - ONS data
  - Reveal high risk zones
- Feature selection: SelectFromModel(Random Forest).
- Models: LR, RFC, SVC, XGBoost.
- Optimised using GridSearch
- Ensemble approach: Soft Voting Classifier
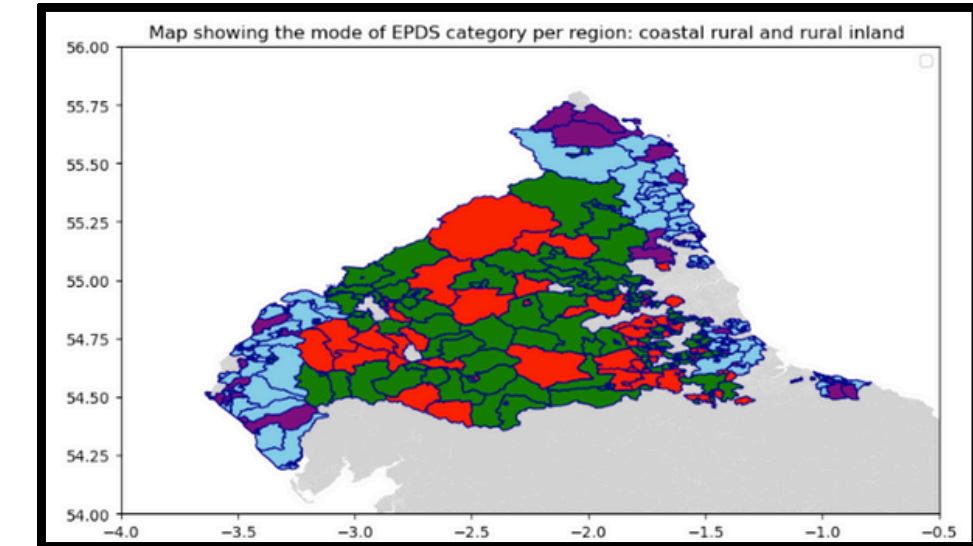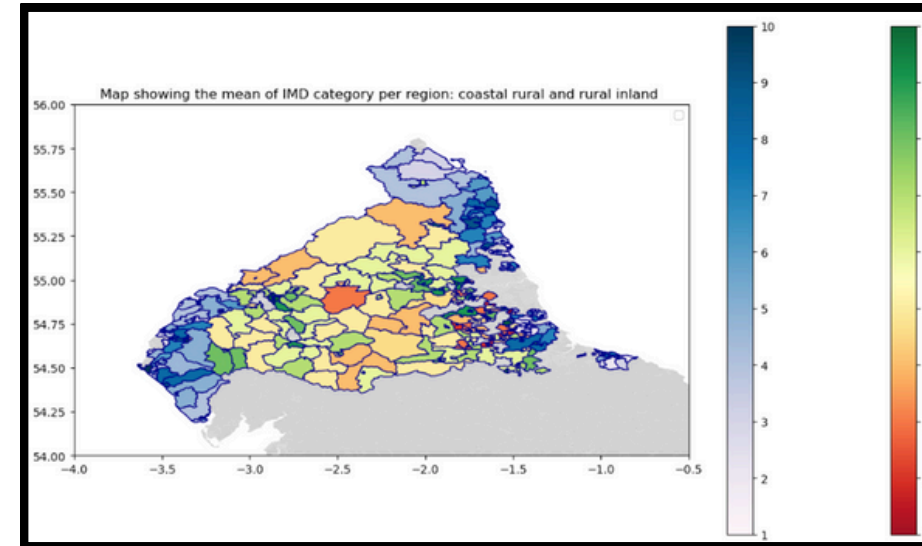
Maternal Mental Health Dashboard
- Flask, CSS - Bootstrap, Matplotlib/Plotly
- Cloud-hosted models (Hugging Face)
  - Worsening risk score
  - Perinatal safeguarding risk flag
- Gemini API, time series with ARIMA forecasts, text summary.
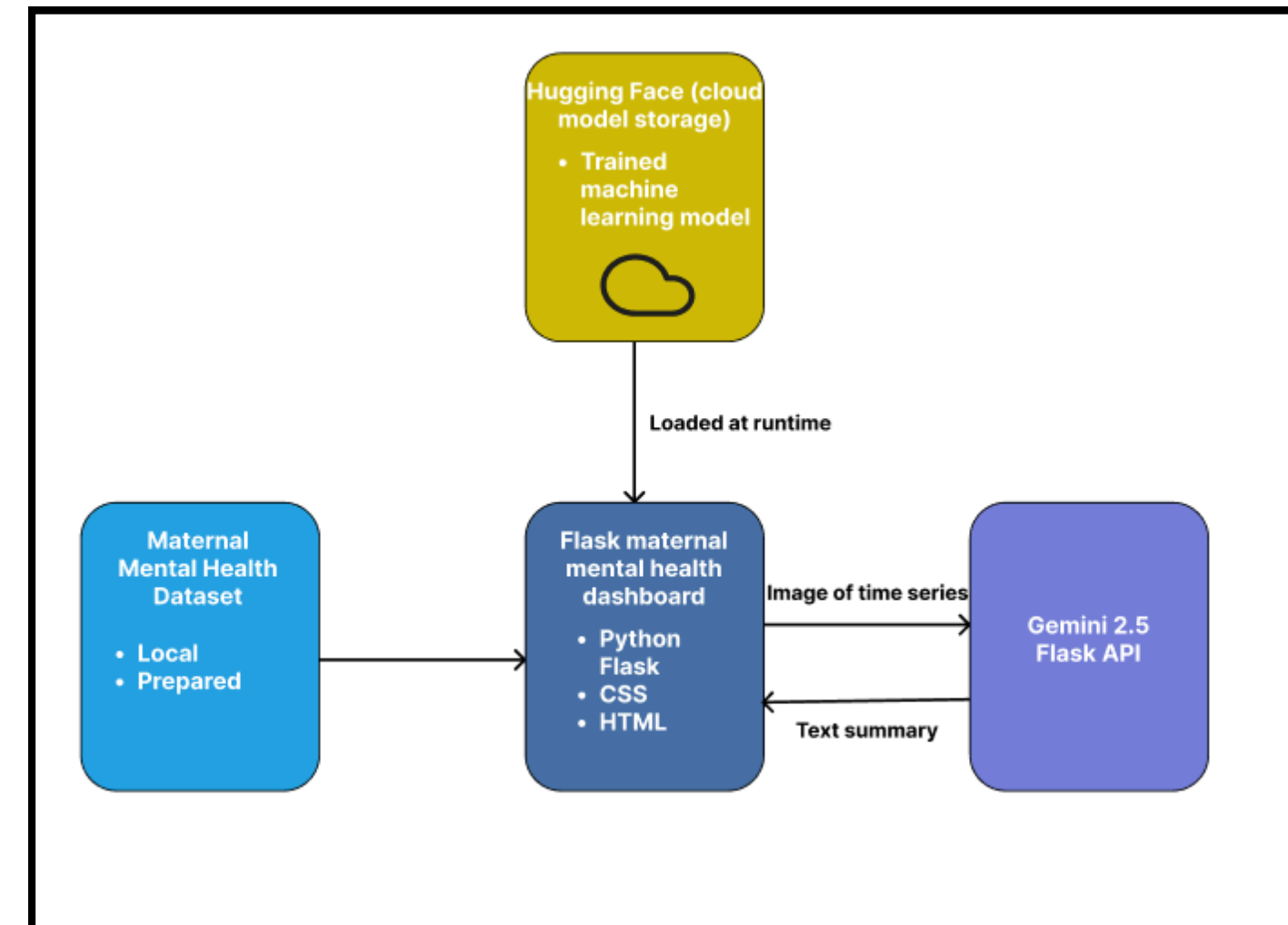
RESULT

- Final voting classifier: most stable and robust performance.
- High PPV → Fewer false positives.
- High NPV → Fewer false negatives.
- SHAP values → Key features driving predictions.

- Patient-level insights from multifactorial data
- Scalable model integration: cloud hosted
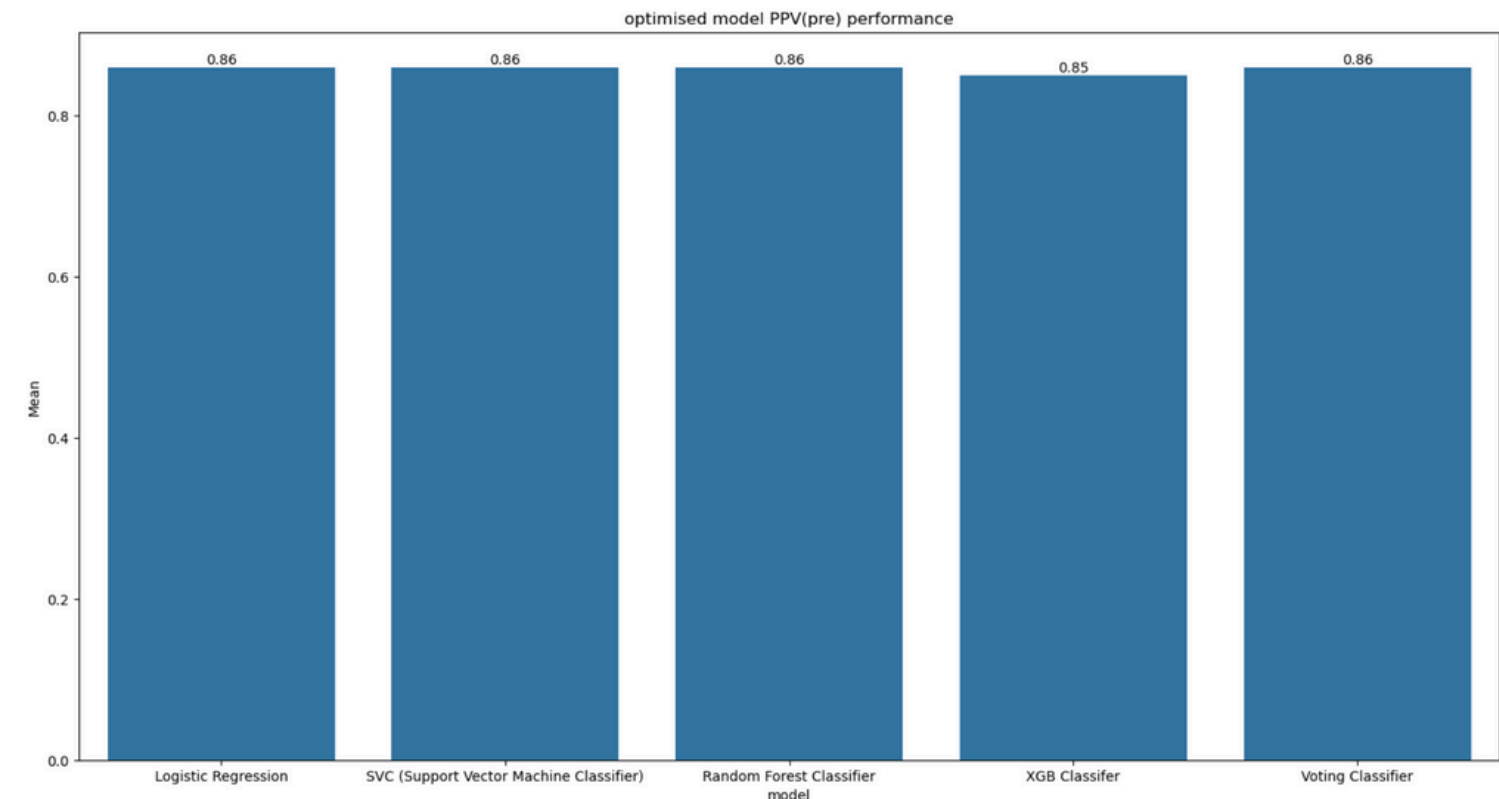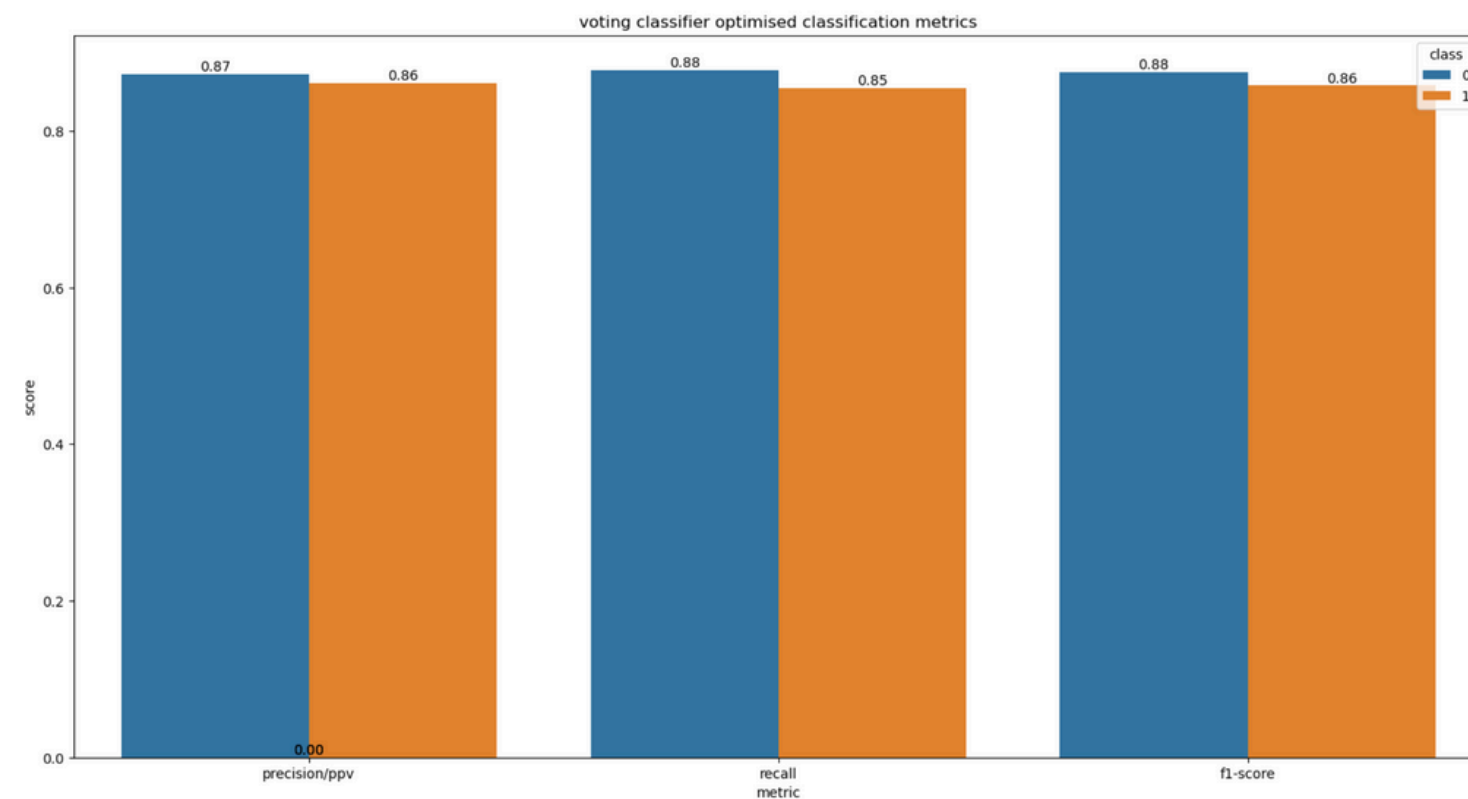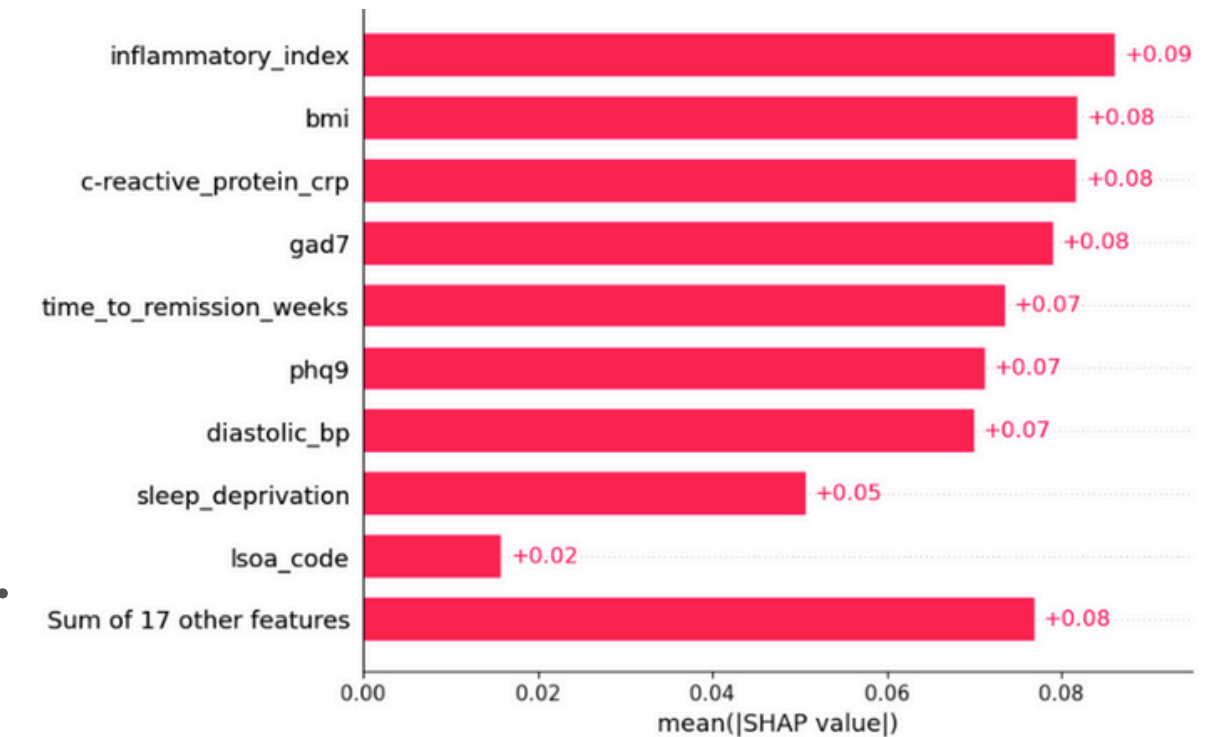- Time-series of outcomes with key events (medication, VCSE, delivery)
- Gemini: Summarizes patient data visualisations for faster review.
- Perinatal safeguarding risk: flag status, meaning, suggested actions and trigger
- factors.

Patient Journey Outlook

Patient ID: P_00001

Date of First Encounter: 2022-03-29

Date of Last Encounter: 2024-04-01

Patient Summary

P_00001, 38-year-old with body mass index of 28.3, presented with Psychosis.

Medical history includes Psychosis, Depression, Bipolar Disorder, and Anxiety.

Reports Symptom history includes Appetite Changes, Sleep Issues, Fatigue, Psychosis, Schizophrenia, Severe Panic Attacks, Post-traumatic stress disorder, Mood Swings, Bipolar Disorder, and Anxiety.

Early Postnatal (weeks 0-8)	No valid visit records
Late Postnatal (weeks 9-52)	97.2 %
Overall Maximum Risk	99.2 %
Predicted Class	1
VCSE Support Used	False

EPDS Scores Over Time for Patient P_00001 vs Regional Average

Predicted Clinical Observations

Model prediction 15.0 % probability of worsening condition if current trend persists.

Predicted Outcome: Relapse risk identified

Conclusion & Recommended Next Steps

Recommended action:

- Multifactor risk: Consider case management or multidisciplinary review
- Refer to social support housing service
- Trauma-informed psychotherapy
- Physical activity programme referral

Perinatal Safeguarding Risk

Flag Status	Meaning	Suggested Clinical Actions
perinatal_safeguarding_risk = 1 (Red)	significant psychosocial or psychiatric risk to perinatal safety	Mobilise safeguarding response; assess further

Top Factors Influencing the decision

1. History Suicide Attempt
2. Relapse History
3. History Self Harm
4. Dementia
5. Drug Substance Abuse

GAD-7 Forecast (1-Year) with 95% CI - Patient P_00001

Graph Insight

Here's an analysis of the GAD-7 Forecast chart:

- **Patient ID:** P_00001
- **Time Range:** The observed data starts around March 2022 and ends around March 2024. The forecast extends to approximately March 2025.
- **Observed Trend:** The observed scores show fluctuations. Initially, there's a dip, then a rise, a significant drop, another rise, and then a sharp decline just before the forecast start. There's no clear consistent rising or falling trend, but rather variability.
- **Forecast Start Point:** The forecast begins around March 2024, indicated by the dotted vertical line.
- **Forecast Pattern:** The forecast (orange dashed line) shows a relatively stable pattern, hovering just below 10.0, specifically around 9.8, for the entire forecast period.
- **Confidence Interval:** The 95% Confidence Interval (shaded orange area) is initially quite narrow at the forecast start but widens significantly over the 1-year forecast period, indicating increasing uncertainty further into the future.
- **Key Events:**

DISCUSSION

In what ways can machine learning can be leveraged to explore patterns, predictors and classification in maternal mental health outcomes?

- Data processing, EDA, Modelling, Optimisation, patient-level dashboard deployment.
- Found ensemble model offered, stable, robust performance as a risk prediction tool; multifactorial nature of maternal mental health captured well.
- Integration and scalability: proof-of concept web app, scalable model integration and LLM for clinician support

- NHS 10 year plan shows that tools like this will be explored for **support**.
- **Next Steps:** Validate on real clinical datasets, clinician input in design, explore NHS integration.