A Multimodal Machine Learning framework for Psychosis Prediction: Sleep and Behavioral Approach

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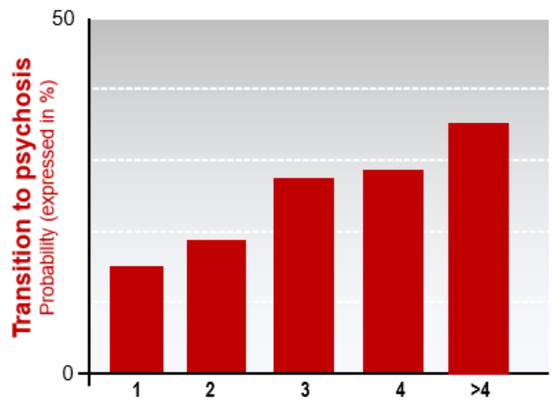
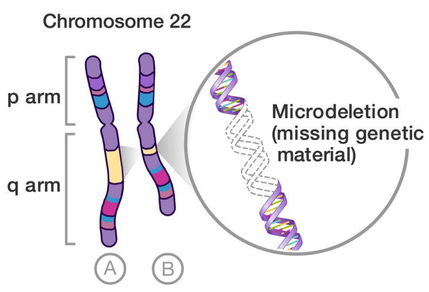
1. Introduction

- Psychotic disorders are common, affecting approximately 3% of the general population [1][2][3]
- Hallucinations and delusional thoughts are the regular symptoms but could culminate to impaired cognition, reduced life expectance, social isolations etc. [3][4]
- Sleep influences cognition and the risk of psychosis across lifespan – how or why remains **unclear**
- Copy Number Variants (CNV) are chromosomal mutations that increase risk of psychosis by up to 12x
  - 1q21.1 del, **22q11.2** del, and 16p11.2 dup [5][6]
- Sleep disruption in young CNV carriers
  - Altered sleep architecture & abnormal brain activity in NREM sleep
- There is no current framework for predictive model in this population – **1 in 4000** people carry 22q11.2 DS alone [8]



[7]



"We have a **constant battle with sleep**…The next day his window of **tolerance is just so low** - he fights with his sister, kicks cupboards"

"Oh my god, **the nights are terrible**… she gets so restless, she starts kicking, screaming, like really **aggressive**"

2. Hypothesis

The integration of sleep patterns, actigraphy data, blood biomarkers, and cognitive measures significantly improves the prediction of psychosis risk in children with CNVs compared to using each data source alone

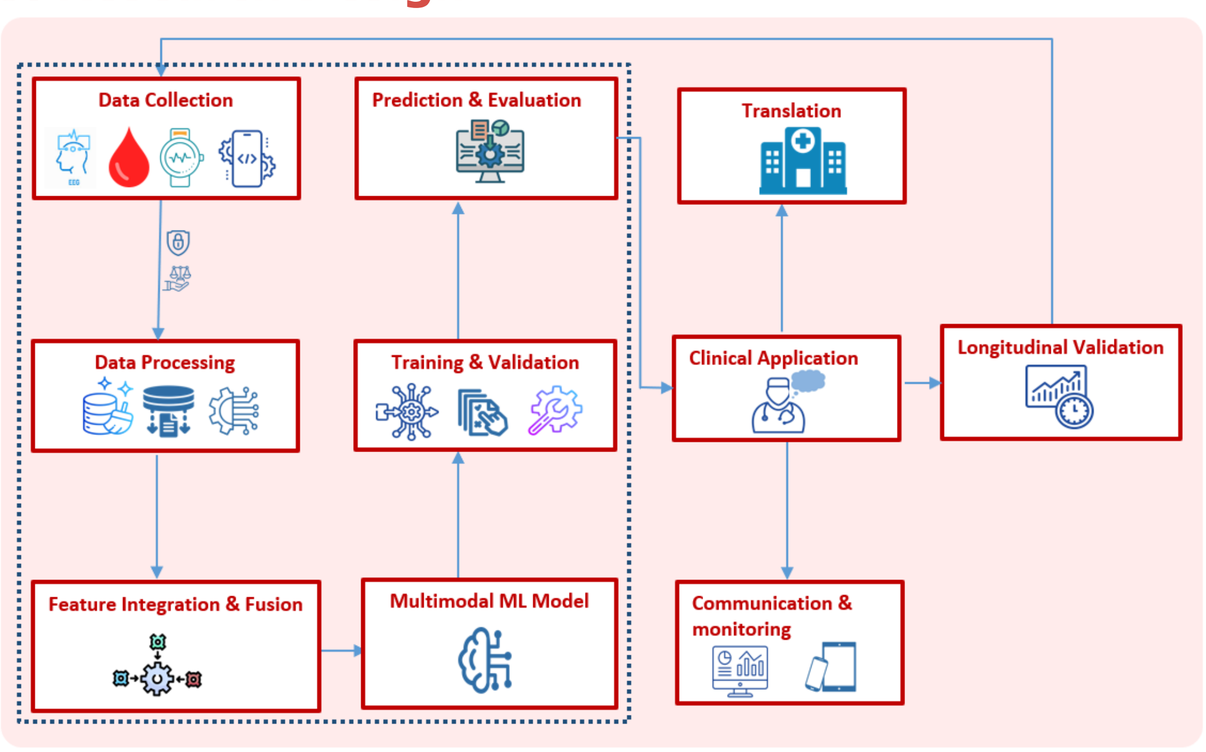
3. Aim

To quantify how early behavioural and neurophysiological signatures of sleep health associate with impaired cognition and psychosis risk in children

4. Objectives

- To collect and analyze data on sleep data patterns (EEG, Actigraphy) and behavioral neurobiological markers - using EEG (and potentially MRI)
- To work with participants and their carers to define the ethical concerns relating to using such data among young adults
- To develop a pipeline to stratify sleep data in children carrying psych-CNVs
- To develop a risk-predictive machine learning framework relating sleep, cognition and psychotic symptoms
- To develop a mobile app for monitoring and communication – with the patients (and/or their carers) and the clinicians

5. Research Design



6. Methodology

- Data will be collected from more than 100 participant – individual with CNV and their unaffected siblings
- Data will be pre-processed for noise removal and extraction of relevant features
- A fusion technique will be implemented in fusing the data modalities together
- Machine learning model will be developed – to integrate data from several modalities together. Data will be divided into training and testing parts
- Model will be validated using external data source

7. Timeline and Milestones

Milestones	Year 1				Year 2				Year 3			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Familiarization, Ethics Application & literature review	■											
Data Collection and Processing/PWLE Engagements		■			■			■				
Feature Engineering and Fusion			■									
Multimodal Machine Learning Models				■	■	■						
Validation and Performance Evaluation					■			■				
Interpretability and Explainability						■						
Clinical collaborations/conference/journal preps							■					
Optimization and Model Refinement					■	■	■	■				
Ethical Consideration and Privacy									■			
Integration and Deployment									■	■		
Thesis Write up		■		■		■		■		■	■	
Thesis Submission												■

8. Risks

- Recruitment
- Instability of EEG devices markets

9. References

Scan here for a list of references →

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