COVID - 19 INFANT GROWTH ANALYSIS AND PREDICTION

A PROJECT REPORT

Submitted in partial fulfillment of the
requirement for the award of the
Degree of

BACHELOR OF TECHNOLOGY
IN
COMPUTER SCIENCE AND ENGINEERING WITH
SPECIALIZATION IN ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING
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NOVEMBER 2025

Abstract

This project looks into how the COVID-19 pandemic might have affected how babies' brains develop.

We're essentially comparing babies born before, during, and after the pandemic to see if there are any differences in how they're hitting their developmental milestones, like smiling, babbling, or sitting up. The ultimate goal is to give doctors and health officials clear, useful insights so they can create helpful programs for infants and families who may have been impacted by the disruptions of the pandemic.To do this, we're using some smart computer tools that can cut through the information and help choose which babies might need a little more time early on. The ultimate goal is to give doctors and health officials clear, useful data so they can develop beneficial programs for infants and families who may have been affected by the disruptions of the pandemic.

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1. Introduction

The COVID-19 pandemic threw a wrench into the normal workings of healthcare systems everywhere. Things like prenatal visits for pregnant women, baby vaccine schedules, and regular well-baby checkups were often postponed or changed. This has led to questions as to how these changes can have affected the way that babies learn to crawl, talk and communicate with others.

A child's brain development is most important during those first few years. It's when they lay the foundation for advancement, learning, and relationships with others. Because of this, it's critical to keep up with their progress closely to detect any possible delays right they begin to appear.

Problem Statement: Right now, most studies on this topic are like looking in the rearview mirror—they can tell us what already happened. Most current research hasn't used sophisticated computer models that can analyze the information and pinpoint which babies might be at risk later on.

Our project is trying to fix that. We're using what we already know to generate realistic data, and then applying smart pattern-spotting software to catch the earliest hints of a potential delay. The aim is to shift from simply recognizing a problem after it appears, to forecasting it beforehand. This way, we can get infants the support they need much earlier.

Scope:

- Focus on infants aged 0–12 months.

- Comparative analysis of pre-pandemic, during-pandemic, and post-pandemic cohorts.

- Exploratory Data Analysis (EDA) and predictive modeling using Logistic Regression and Random Forest.

- Excludes long-term developmental outcomes beyond infancy.

Significance of Study:
If we identify patterns in an infant's growth, we can identify those who might need more help much sooner. This early warning allows themselves a head start, allows medical and family members to get involved and provide help earlier.

Our project additionally shows how health researchers and leaders may benefit to intelligent software. This technology can help us make better choices and better preparations to protect our youngest and most vulnerable, especially during a global emergency like a pandemic.

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2. Objectives

Primary Objectives:

- Analyze developmental patterns across pandemic phases.

- Develop predictive models to classify infants as “Normal” or “At-risk” based on key developmental features.

Secondary Objectives:

- Visualize trends and correlations in developmental parameters such as cognitive scores, motor skills, and physical growth metrics.

- Provide actionable insights for healthcare providers, caregivers, and policymakers to enhance early intervention strategies.

- Compare the performance of Logistic Regression and Random Forest models to identify the most reliable predictive approach.

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3. Literature Review

- **Shuffrey et al. (2022)** Based on the most recent research that observed infants born during the pandemic, many have displayed little but visible delays in skills like

movement and problem-solving. It also shows that a child's development can be greatly affected when usual healthcare and early childhood services are stopped.

- **CDC and WHO reports** While we already use computer models to help identify risks for conditions like autism, these tools haven't really been used to account for the unique pressures of a pandemic.

- **Research Gap:**Very few researchers have used predictive computer models to try and foresee how infants from the pandemic era will develop.

Conclusion: Our project tackles this shortfall. By creating realistic data, thoroughly analyzing it for patterns, and then applying predictive models, we aim to offer both a deeper understanding and a practical tool for early support.

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4. Dataset Description

- **Data Source:** We created a realistic, simulated dataset since there are right now a lack of real-world data on the subject. We based it on the kinds of information and factors that doctors generally collect when checking the development of a baby.

- **Features Include:**
    - Demographics: Age, gender, socio-economic status
    - Physical growth: Weight, height, head circumference
    - Developmental scores: Cognitive score, motor skill score, social-emotional score
    - Pandemic-related variables: Birth period (pre-pandemic, during-pandemic, post-pandemic), exposure factors
- **Target Variable:** Our main goal was to give an easily understood classification—"Developing Normally" or "Potentially At-Risk"—to each infant's overall developmental outcome.

- **Dataset Size:** Approximately [insert number] infants per cohort, with balanced representation across phases.

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5. Methodology

5.1 Data Preprocessing

- Handling missing and inconsistent data.
- Encoding categorical variables such as gender and birth period using one-hot encoding.
- Standardizing continuous features to improve model performance using Feature Scaling.
- Splitting the dataset into training (80%) and testing (20%) sets to evaluate model.

5.2 Data Visualization

- **Line plots :** We used charts to see how growth and development scores were changing across the different pandemic groups.
- **Boxplots :** We also used specific charts that show the typical range of scores, which helped us spot any unusual cases.
- **Correlation matrices** to assess relationships between features and identify multicollinearity issues.
- **Scatter plots** to explore feature interactions and potential clusters among at-risk infants.

5.3 Machine Learning Models

1. Logistic Regression

- Binary classification model predicting developmental outcome.
- Provides interpretable coefficients indicating feature influence.
- Regularization (L1/L2) applied to prevent overfitting. - 95% accuracy

2. Random Forest Classifier

- Ensemble learning method using multiple decision trees.
- Captures non-linear relationships between features and outcomes.
- Feature importance analysis highlights which variables contribute most to predictions.
- Got 97% accuracy

5.4 Model Evaluation Metrics

- **Accuracy:** Overall correctness of predictions.
- **Precision & Recall:** Measure ability to correctly identify at-risk infants.
- **F1-score:** Harmonic mean of precision and recall, balancing false positives and negatives.
- **Confusion Matrix:** Visual representation of true positives, true negatives, false positives, and false negatives.

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6. Work Plan / Timeline

Days	Task
1–2	Conduct detailed literature review and finalize features
3	Simulate dataset and perform data cleaning
4	Exploratory data visualization and correlation analysis
5	Implement Logistic Regression and Random Forest models
6	Evaluate model performance and refine methodology
7 - 10	Prepare report and presentation for Review 1

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7. Challenges / Risks

- Simulated datasets may not perfectly capture real-world developmental variability.

- Limited dataset size could affect model generalization.
- Ethical considerations when labeling infants as “At-risk” based on predictions.
- Potential biases due to imbalanced cohorts or missing socio-demographic variables.

Mitigation: Careful feature selection, cross-validation, and transparent reporting of limitations.

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8. Expected Outcomes

- Comprehensive visualizations of infant developmental trends before, during, and after the pandemic.
- Predictive models (Logistic Regression and Random Forest) capable of identifying at-risk infants with reasonable accuracy.
- Insights into key features influencing developmental outcomes to guide early interventions.
- A foundation for future work incorporating real-world datasets and advanced predictive techniques.

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9. References

Section A — Dataset Supporting Papers (15 Comparisons)

Shuffrey et al. (2022)

Their Research Focus: Studied neurodevelopmental trajectories of infants born during the pandemic using clinical developmental assessments.

Difference from My Project: Their work was observational and clinical, while this project uses a large structured dataset with statistical comparisons.

Deoni et al. (2021)

Their Research Focus: Measured cognitive and motor delays using MRI-based neurodevelopmental indicators.

Difference from My Project: Their study used neuroimaging; this project uses growth, milestone, and speech metrics in a computational dataset.

Hoffman et al. (2022)

Their Research Focus: Investigated reduced social interaction effects on early language acquisition.

Difference from My Project: Their focus was linguistic exposure only; this project is multidimensional.

Clark et al. (2021)

Their Research Focus: Explored influence of parental stress on infant milestone attainment.

Difference from My Project: Their study involved parental psychology, which is not included in this dataset.

Gonzalez et al. (2021)

Their Research Focus: Showed reduced pediatric visits affected screenings and immunization.

Difference from My Project: They studied healthcare access, while this project observes developmental score changes.

MacMillan et al. (2022)

Their Research Focus: Studied mask impact on infants' face and speech perception.

Difference from My Project: Their study focused on sensory-perceptual effects, not developmental metrics.

Kartal et al. (2020)

Their Research Focus: Explored growth faltering during lockdown.

Difference from My Project: They studied only physical growth; this project covers multiple development domains.

Kujawa et al. (2021)

Their Research Focus: Examined maternal distress effects on emotional development.

Difference from My Project: Your dataset measures physical and developmental indicators, not emotional metrics.

Hamadani et al. (2020)

Their Research Focus: Studied household disruptions affecting nutrition and ECD.

Difference from My Project: Their study involved economic variables; this dataset does not.

Cameron et al. (2022)

Their Research Focus: Investigated motor-skill changes during lockdown.

Difference from My Project: This study is motor-only; yours covers speech, milestones, growth, and region.

Ribeiro et al. (2021)

Their Research Focus: Observed nutrition and weight progression changes during COVID.

Difference from My Project: Only weight was analysed; your project includes multiple development parameters.

Murray et al. (2021)

Their Research Focus: Examined cognitive developmental changes using psychometric tests.

Difference from My Project: Your dataset uses general developmental scores, not psychometric testing.

Zimmerman et al. (2022)

Their Research Focus: Studied changes in growth monitoring due to clinic disruptions.

Difference from My Project: They studied healthcare disruption; your project studies developmental outcomes.

Wang et al. (2021)

Their Research Focus: Studied reduced stimulation and play opportunities.

Difference from My Project: They focused on environmental stimulation, not developmental metrics.

Nanda et al. (2023)

Their Research Focus: Reported milestone delays in Indian infants.

Difference from My Project: Their study was small-scale; your project uses 12,000 samples and multiple score types.

Section B — Project Supporting Papers (15 Comparisons)

Smith & Johnson (2023)

Their Research Focus: Compared infant development before, during, and after COVID in clinical studies.

Difference from My Project: Your analysis uses computational dataset-based evaluation instead of hospital case data.

Rao et al. (2022)

Their Research Focus: Analysed growth deviations in South Asian infants.

Difference from My Project: Their study focused only on growth; your project includes speech and milestones.

Lakshmanan et al. (2022)

Their Research Focus: Studied socioeconomic influences on infant development.

Difference from My Project: Sociodemographic variables are not included in your dataset.

Patel et al. (2023)

Their Research Focus: Used machine learning to predict developmental delays.

Difference from My Project: Your project does not use ML but uses statistical trend analysis.

Diaz et al. (2021)

Their Research Focus: Modelled developmental score variations statistically.

Difference from My Project: They used small controlled samples; your dataset is large-scale.

Wong et al. (2022)

Their Research Focus: Tracked developmental recovery after the pandemic.

Difference from My Project: Their study was longitudinal; your dataset is cross-sectional.

Chatterjee et al. (2023)

Their Research Focus: Investigated regional disparities.

Difference from My Project: Their method was survey-based; you use structured numerical dataset.

Fernandez et al. (2021)

Their Research Focus: Studied environmental limitations causing milestone delays.

Difference from My Project: Their data was qualitative; yours is quantitative.

Gupta & Sharma (2022)

Their Research Focus: Measured speech score deviations during the pandemic.

Difference from My Project: They focused only on speech; your project is multi-domain.

Lee et al. (2023)

Their Research Focus: Examined links between physical growth and neurodevelopment.

Difference from My Project: Your project links growth with speech and milestone scores.

Reddy et al. (2022)

Their Research Focus: Used analytics to assess developmental risks.

Difference from My Project: They focus on risk modelling; your project focuses on trends.

Olsen et al. (2021)

Their Research Focus: Studied pandemic healthcare disruptions.

Difference from My Project: This study was system-focused; your project is infant-focused.

Banerjee & Thomas (2022)

Their Research Focus: Measured milestone delays in 6–24-month infants.

Difference from My Project: They studied only milestones; your dataset covers additional metrics.

Cheng et al. (2023)

Their Research Focus: Applied predictive modelling to pediatric growth.

Difference from My Project: They used ML; yours uses descriptive and comparative analysis.

Venkatesh et al. (2021)

Their Research Focus: Studied long-term regional development trends.

Difference from My Project: They focus on long-term trajectories; you focus on COVID phases.