📊 Project Report: Diabetes Dataset Analysis & Prediction

1. Dataset Overview

- **Records**: 768
- **Variables**: 9
- **Data Types**: 7 int, 2 float
- **Nulls**: None
- **Duplicates**: None
- **Memory Usage**: ~54 KB

2. Variable-Level Summary

Variable	Range (Min–Max)	Mean ± Std	Notes on Distribution	Outliers
Pregnancies	0 – 17	3.85 ± 3.37	Right-skewed; spread almost as wide as mean	High (≥12–17)
Glucose	0 – 199	120.9 ± 32.0	Reasonable spread; skewed right	Low (0), High (>180)
BloodPressure	0 – 122	69.1 ± 19.4	Wide spread; implausible 0 values	Low (0), High (>110)
SkinThickness	0 – 99	20.5 ± 16.0	Many zeros (Q1=0); right-skewed	High (>70)
Insulin	0 – 846	79.8 ± 115.2	Extremely skewed; many zeros	High (>300)
BMI	0 – 67.1	32.0 ± 7.9	Typical BMI spread; invalid zeros present	Low (0), High (>50)
DiabetesPedigreeFunction	0.078 – 2.42	0.47 ± 0.33	Right-skewed; large variability	High (>2.0)
Age	21 – 81	33.2 ± 11.8	Spread across adults; skewed younger	High (>70)
Outcome	0 – 1	0.35 ± 0.48	Binary variable; ~35% positive cases	None

3. Issues Identified

1. **Hidden Missing Data (Fake Zeros)** in BloodPressure, SkinThickness, Insulin, and BMI.

2. **Outliers** in Pregnancies (≥12), Insulin (>300), and Age (>70).
3. **Skewed Distributions** in Insulin, Pedigree Function, Pregnancies, and Age.
4. **Biological Implausibility**: BP = 0, BMI = 0, SkinThickness = 0 → invalid.

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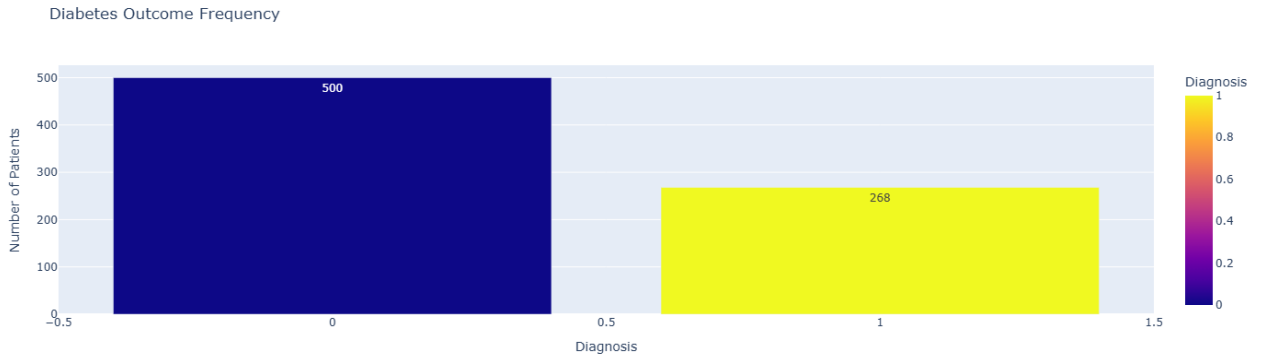
4. Exploratory Analysis & Key Findings

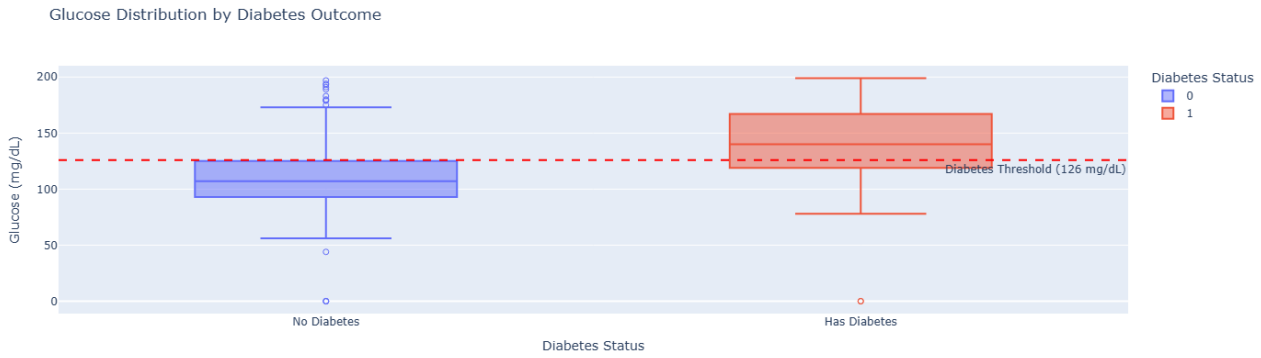
4.1 Outcome Frequency

- **500 non-diabetic vs 268 diabetic patients → class imbalance**.



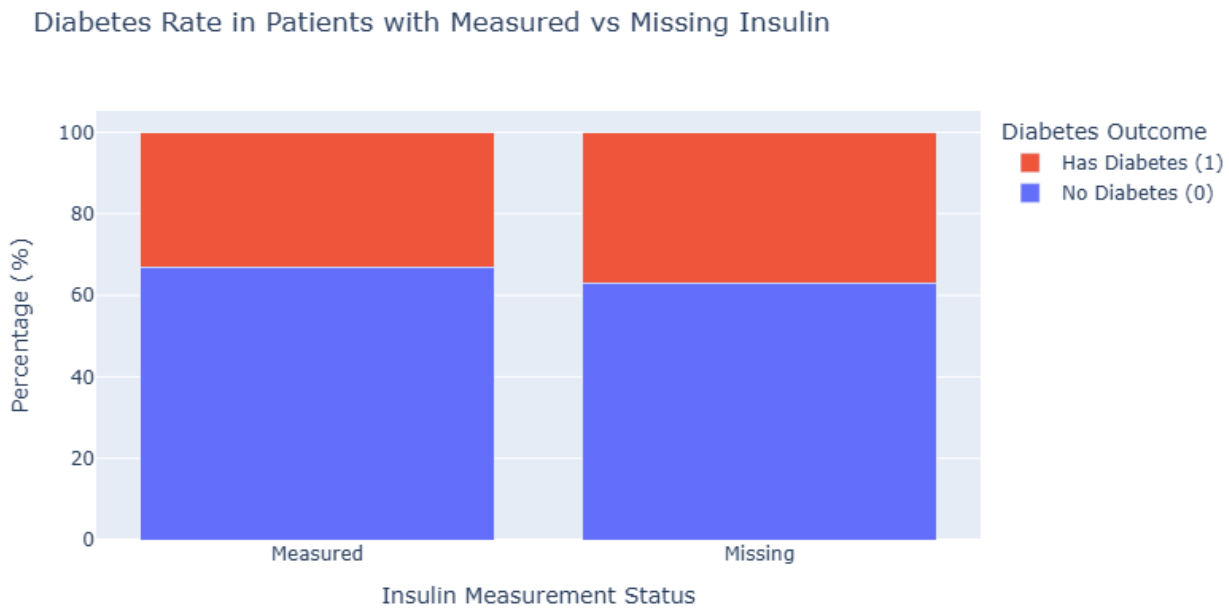
4.2 Glucose by Outcome

- Diabetics have **higher glucose**, median >126 mg/dL.



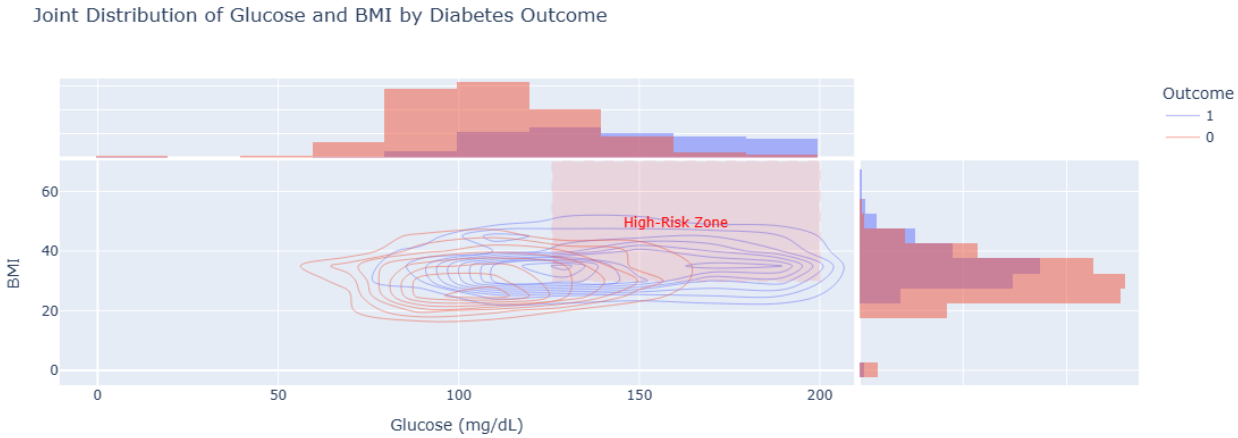
4.3 Missing Insulin vs Diabetes

- Similar diabetes prevalence across missing vs measured insulin.



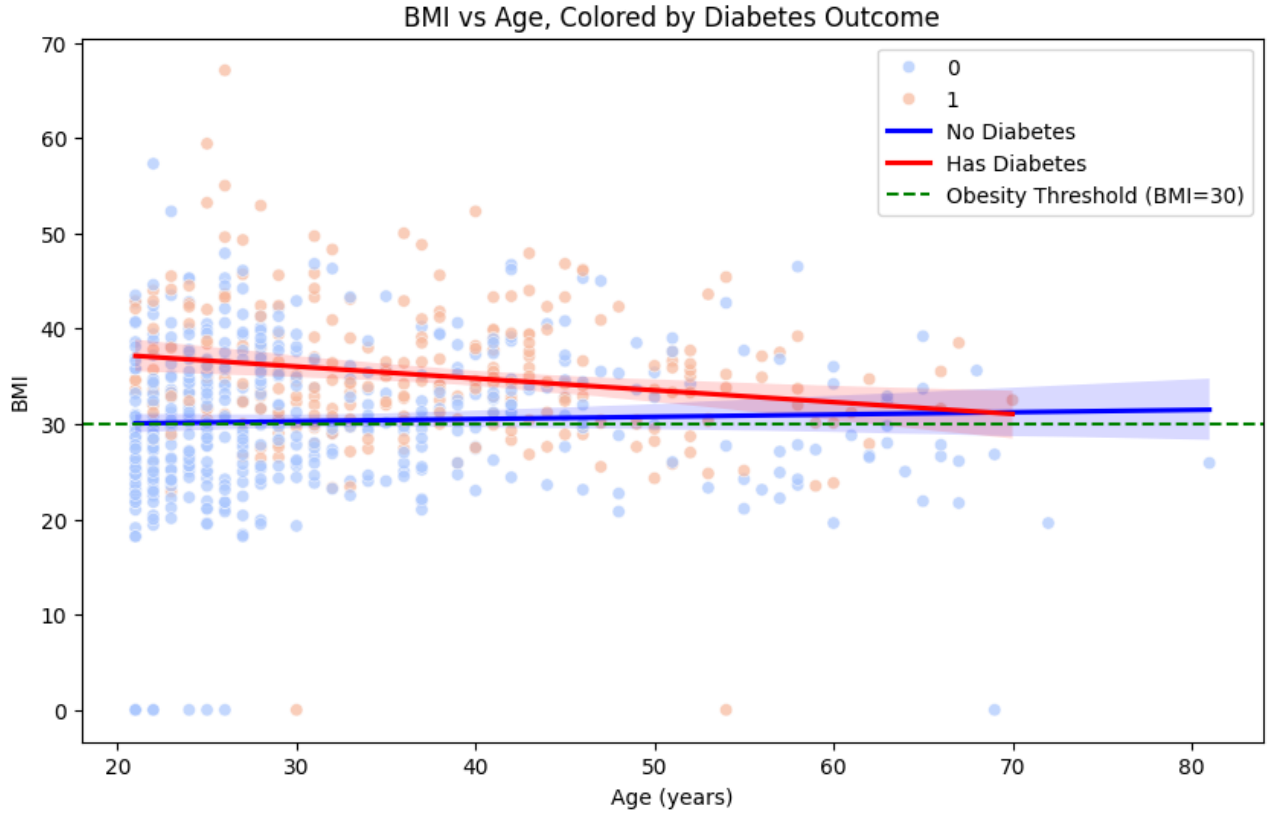
4.4 Joint Glucose & BMI

- **High-risk cluster** = high glucose + high BMI.



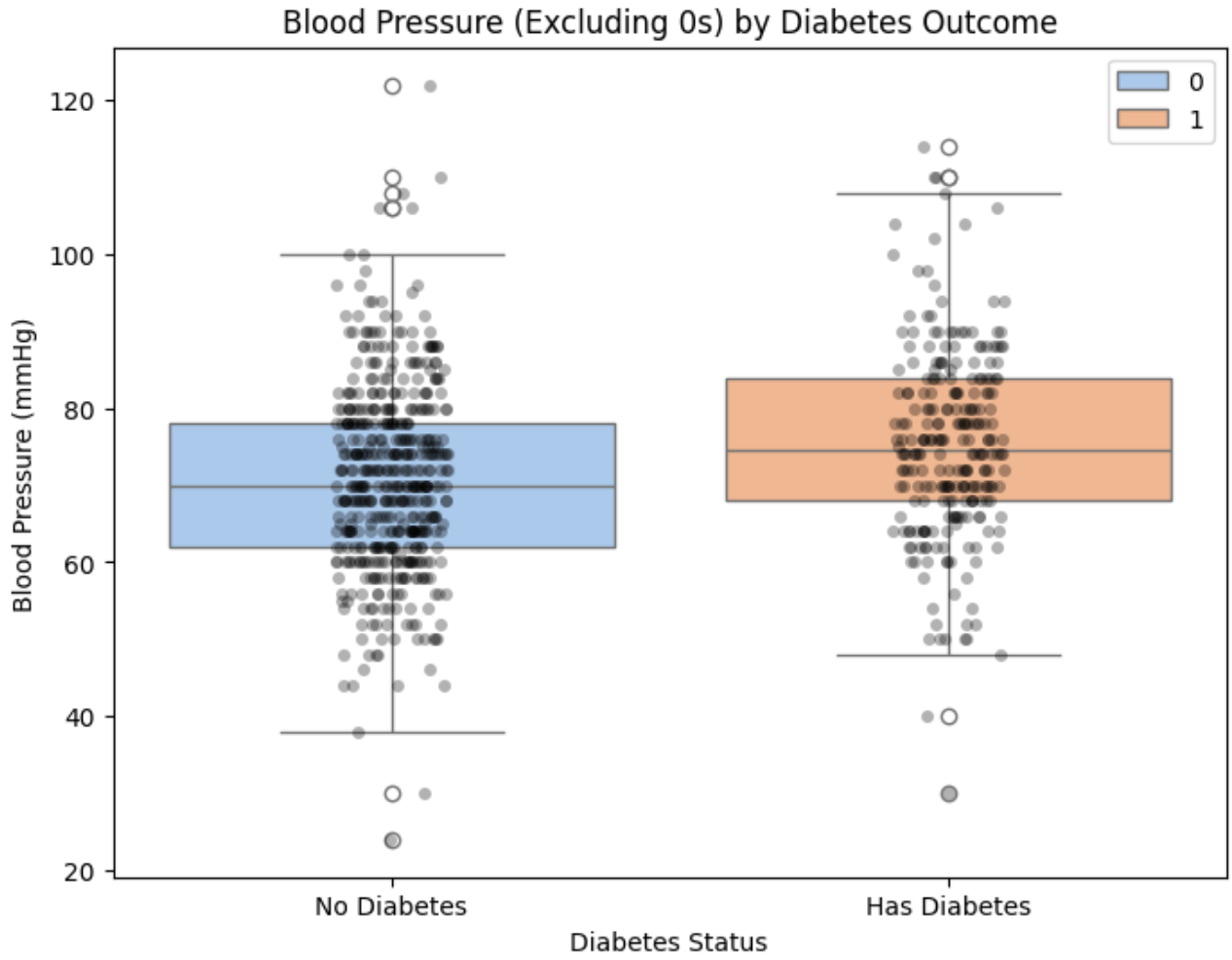
4.5 BMI vs Age

- Diabetics consistently have **higher BMI across all ages**.



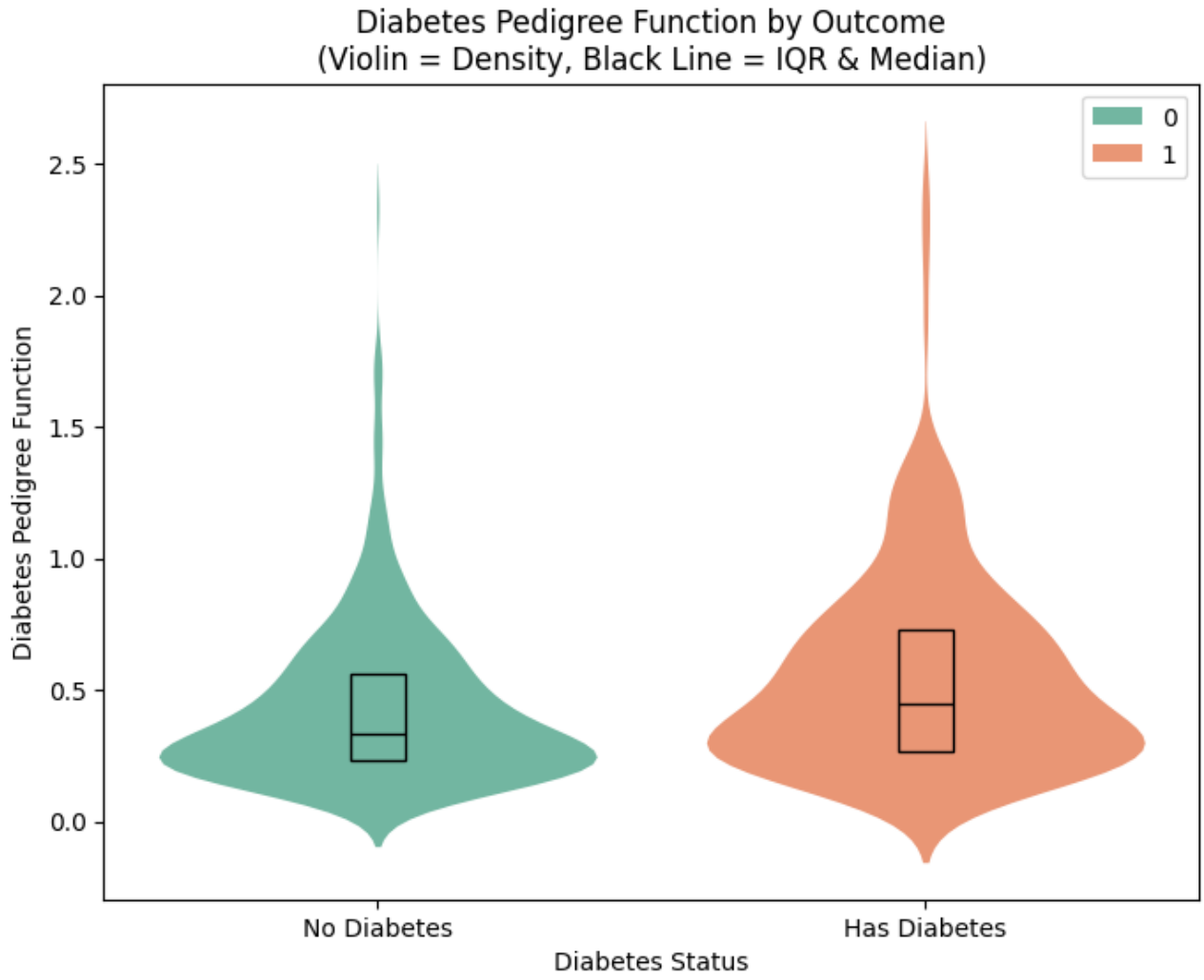
4.6 Blood Pressure (Excluding Zeros)

- Slightly higher BP in diabetics; distributions overlap.



4.7 Pedigree Function

- Higher values in diabetics → stronger genetic predisposition.



4.8 Correlations

- **Top predictors**: Glucose (0.467), BMI (0.293), Age (0.238), Pregnancies (0.222), Pedigree (0.174).
- Insulin & SkinThickness weak predictors.

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5. Modeling Approach

5.1 Preprocessing

- **RobustScaler** used for feature scaling.
- **SMOTE** applied to balance classes (500 diabetic samples).
- **Train/Test Split**: 90/10, stratified.

5.2 Baseline Model Comparison (Before vs After SMOTE)

Model	Test Acc. (Before)	Test Acc. (After)
Logistic Reg.	0.764	0.755
Random Forest	0.759	**0.821**
SVM	0.772	0.794

Model	Test Acc. (Before)	Test Acc. (After)
Linear SVM	0.766	0.755
KNN	0.747	0.786
CART	0.719	0.774
ExtraTree	0.686	0.749

👉 **SMOTE improved performance** across most models.

5.3 Hyperparameter Tuning

- **Random Forest (Best Model)**
  - Test Accuracy: **0.86**
  - Test AUC: **0.90**
  - No overfitting → excellent generalization.
- **SVM**
  - Test Accuracy: 0.84
  - Test AUC: 0.87
  - Slight overfitting (train acc. 0.90).

☑ **Best Choice: Random Forest**

- Robust, stable, and generalizes well.
- Saved as `Random Forest Classifier.pkl`.

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6. Deployment

A **Streamlit web app** was developed for real-time prediction.

Features:

- User inputs (Pregnancies, Glucose, BP, BMI, etc.).
- Model predicts **Diabetes Positive / Negative** with probability.
- Simple and interactive interface.

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7. Summary & Conclusion

- **Glucose** = strongest predictor of diabetes.
- **BMI, Age, and Genetics** contribute significantly.
- **Random Forest** is the best performing model (86% accuracy, AUC 0.90).
- Class imbalance addressed via **SMOTE**.
- Deployed via **Streamlit App** for practical use.

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8. Next Steps

- Further improve missing value imputation.
- Try ensemble methods (XGBoost, LightGBM).
- Deploy app on **Streamlit Cloud / Heroku**.
- Integrate with medical record systems.
