Exploratory Data Analysis of a Diabetes Dataset

By Kyril Verkhovodka

Group: 23-HR-JA1

Object of Study

- A medical dataset of patients with diabetes (Pima Indians Diabetes Dataset).
- **Purpose of the Project/System:** To identify relationships between health indicators and the presence of diabetes, and to create visualizations and statistical analyses to determine risk factors.

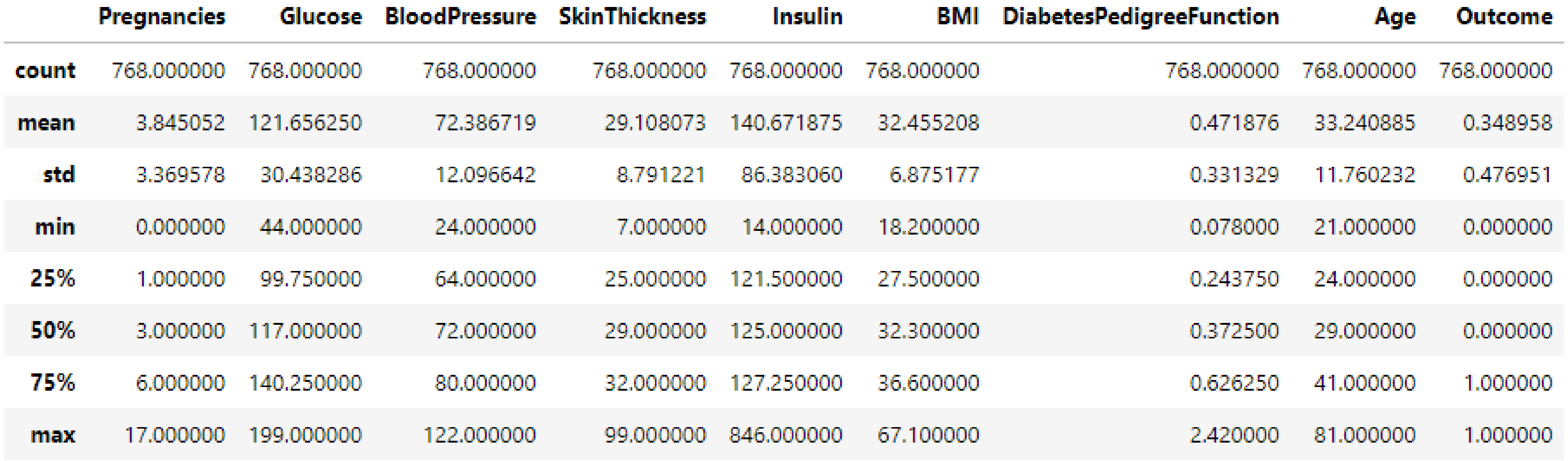
Data Cleaning and Structure

- Table with the first 5 rows of the dataset
- Number of rows and columns
- Data types
- Missing values and unique counts

Main Objectives

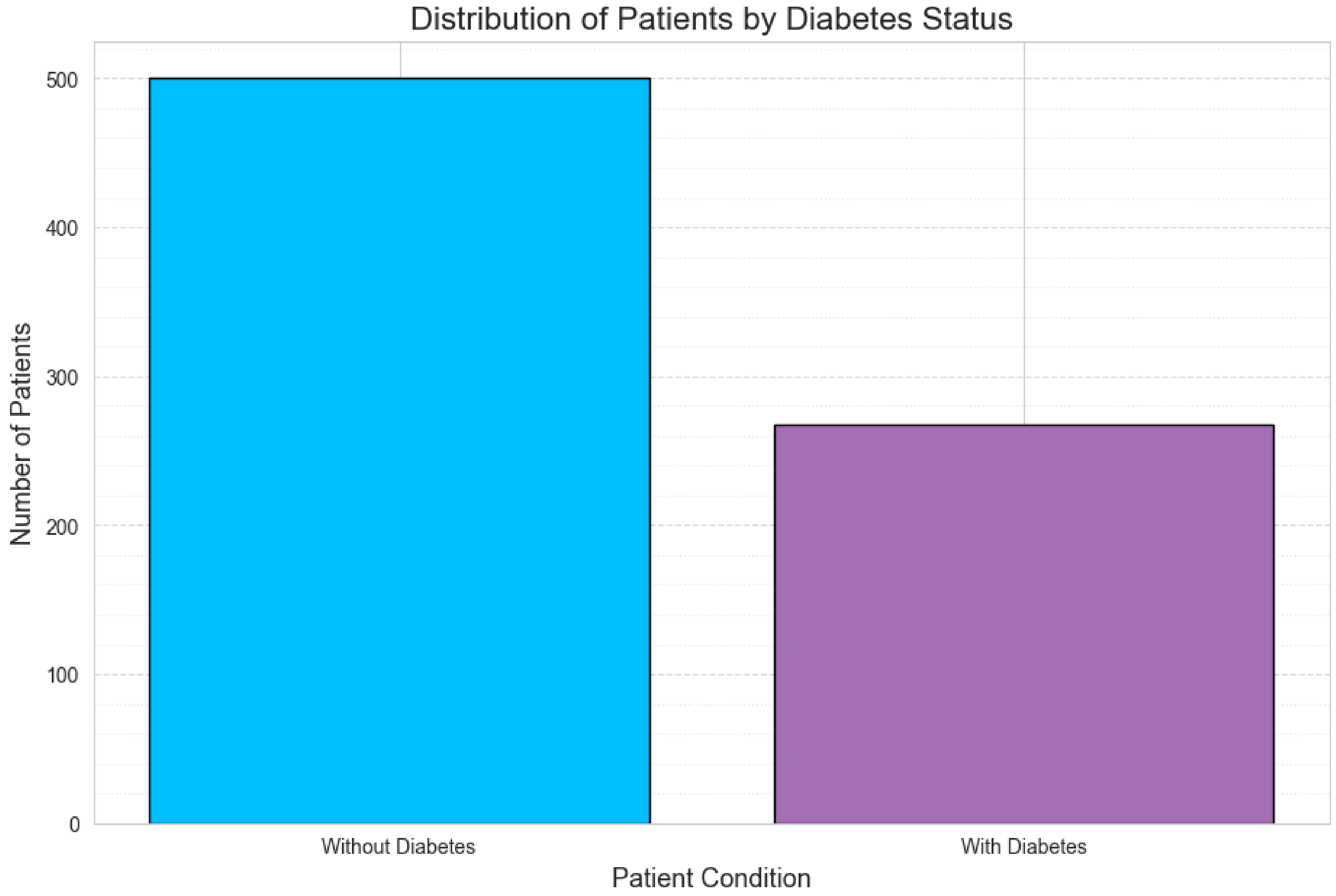
- Explore the dataset and clean the data
- Calculate basic statistics: mean, median, min, max
- Check distributions of numerical and categorical features
- Visualize distributions: histograms, boxplots, violin plots, scatter plots
- Test hypotheses about factors related to diabetes
- Perform clustering and correlation analysis

Basic statistics

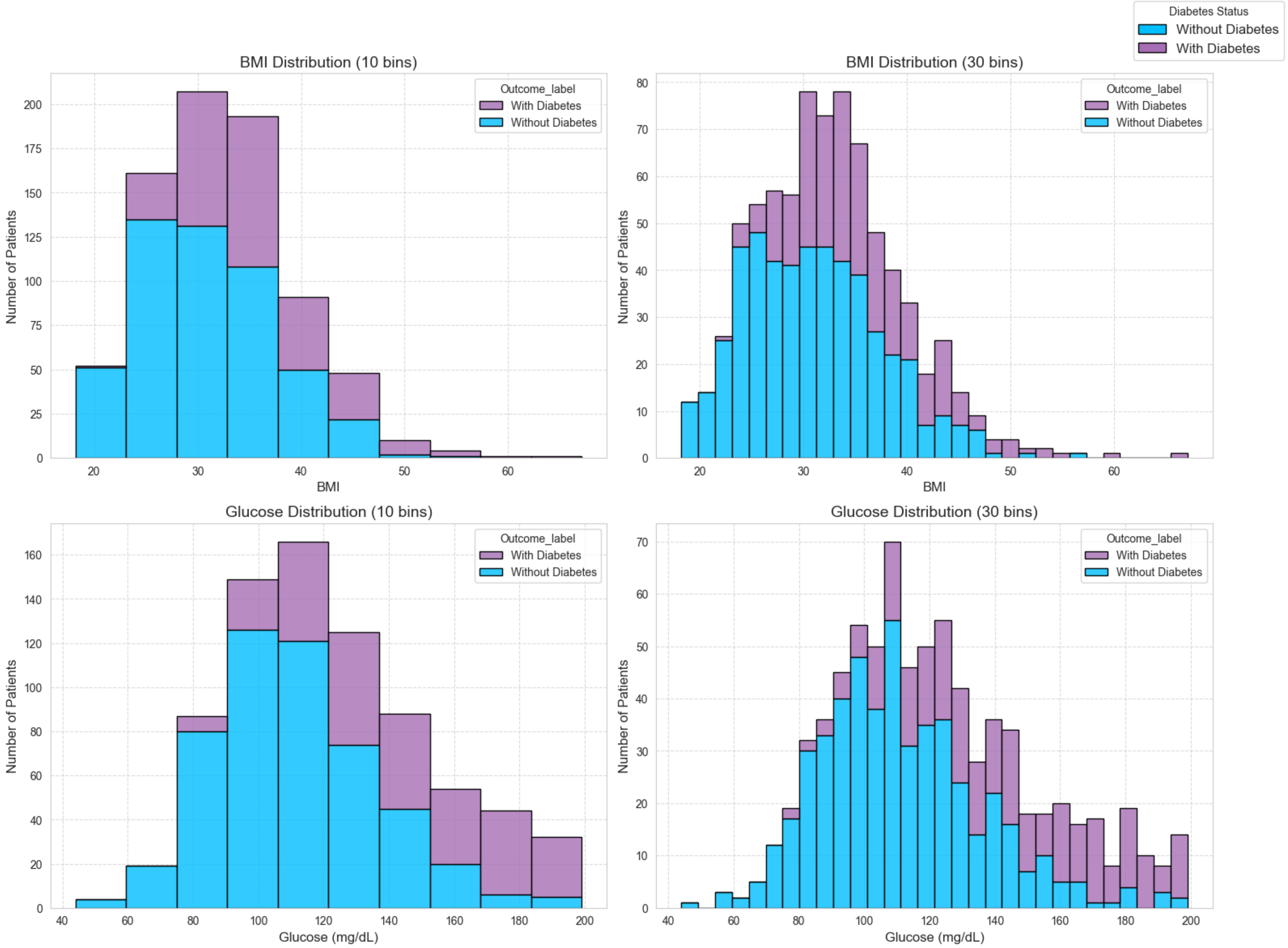


	Pregnancies	Glucose	BloodPressure	SkinThickness	Insulin	BMI	DiabetesPedigreeFunction	Age	Outcome
count	768.000000	768.000000	768.000000	768.000000	768.000000	768.000000	768.000000	768.000000	768.000000
mean	3.845052	121.656250	72.386719	29.108073	140.671875	32.455208	0.471876	33.240885	0.348958
std	3.369578	30.438286	12.096642	8.791221	86.383060	6.875177	0.331329	11.760232	0.476951
min	0.000000	44.000000	24.000000	7.000000	14.000000	18.200000	0.078000	21.000000	0.000000
25%	1.000000	99.750000	64.000000	25.000000	121.500000	27.500000	0.243750	24.000000	0.000000
50%	3.000000	117.000000	72.000000	29.000000	125.000000	32.300000	0.372500	29.000000	0.000000
75%	6.000000	140.250000	80.000000	32.000000	127.250000	36.600000	0.626250	41.000000	1.000000
max	17.000000	199.000000	122.000000	99.000000	846.000000	67.100000	2.420000	81.000000	1.000000

Distribution of Patients by Diabetes Status (Bar Chart)



BMI Distribution (Histogram)



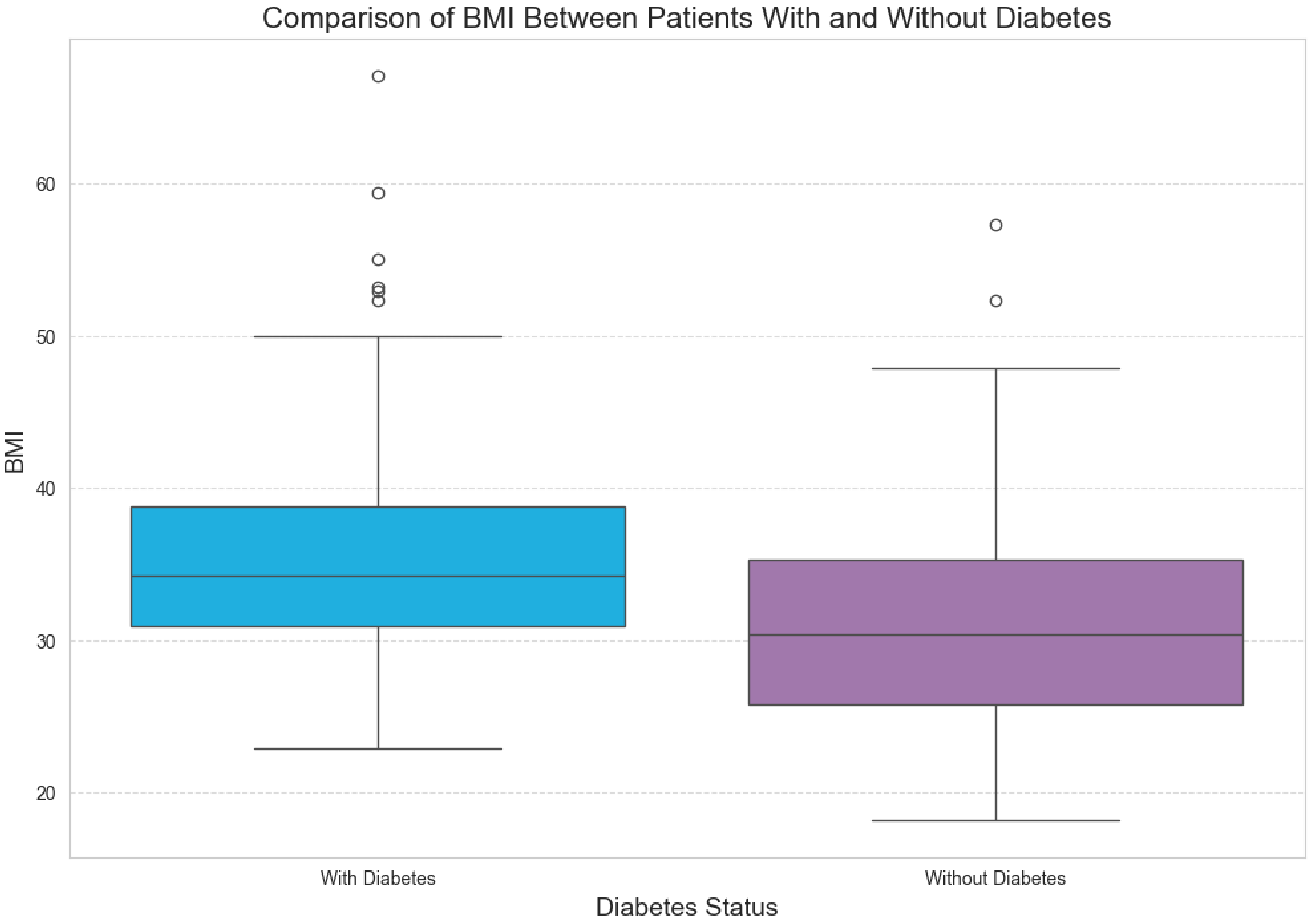
BMI Distribution (10 bins)

BMI Distribution (30 bins)

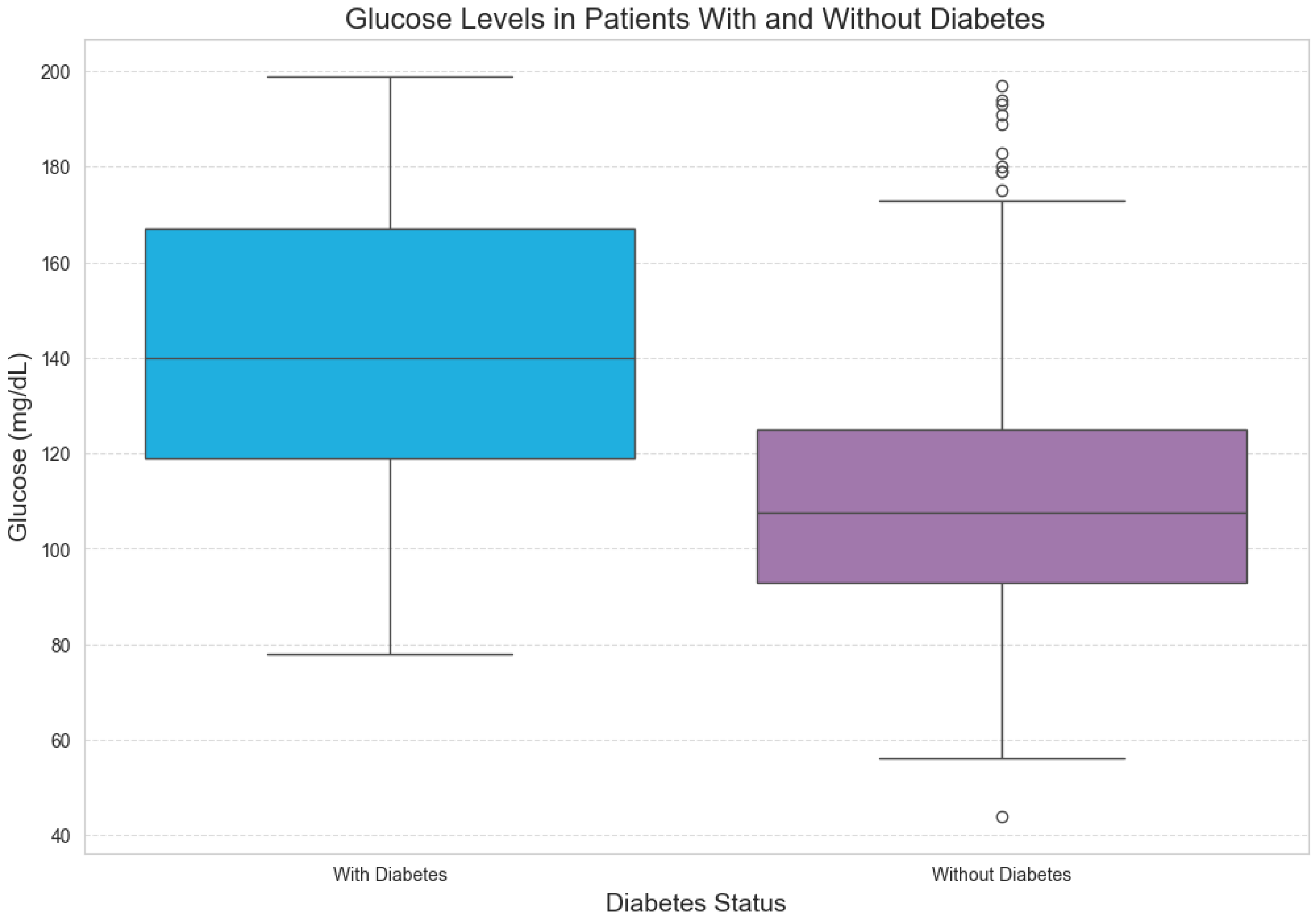
Glucose Distribution (10 bins)

Glucose Distribution (30 bins)

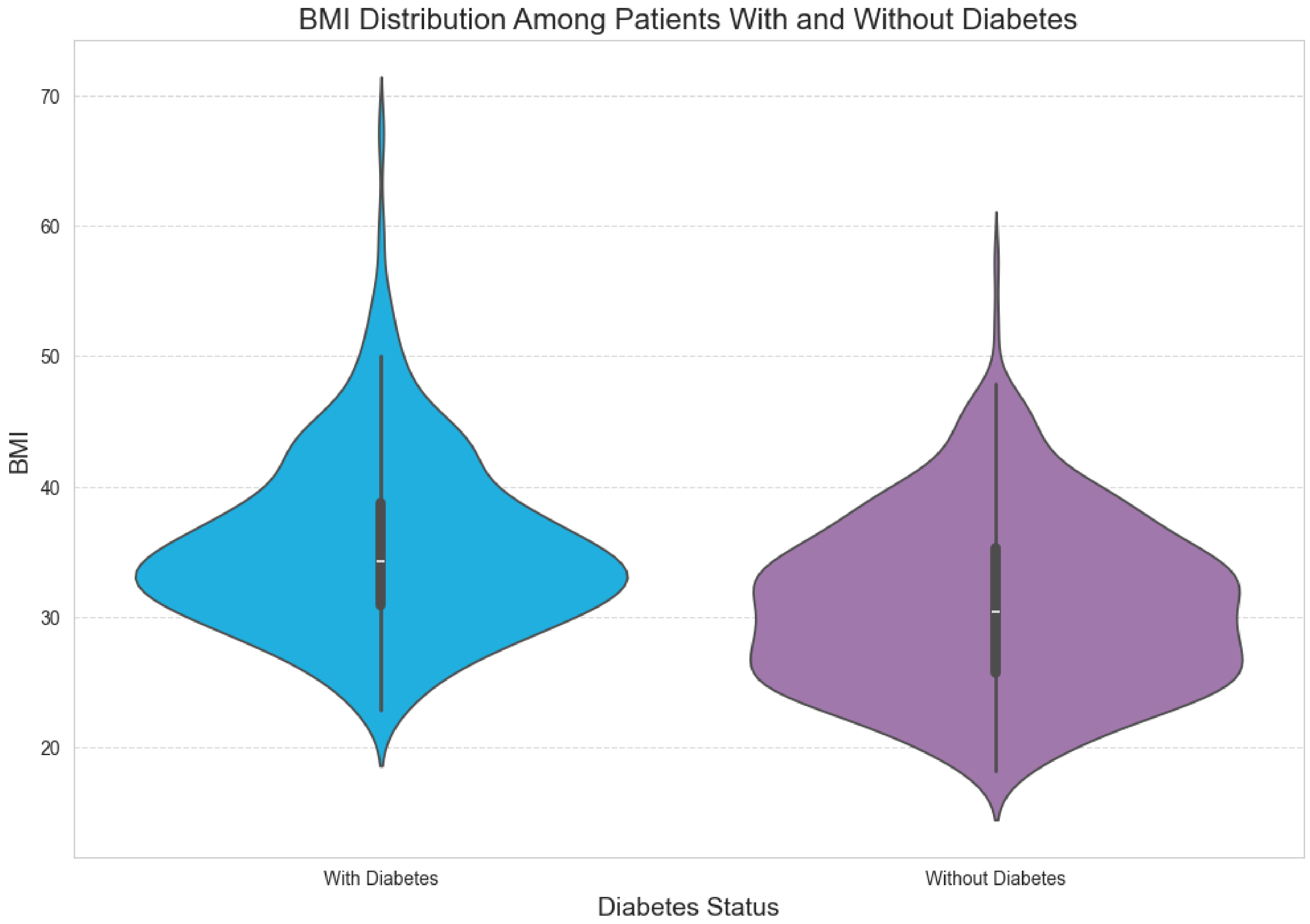
Boxplot – BMI vs Diabetes



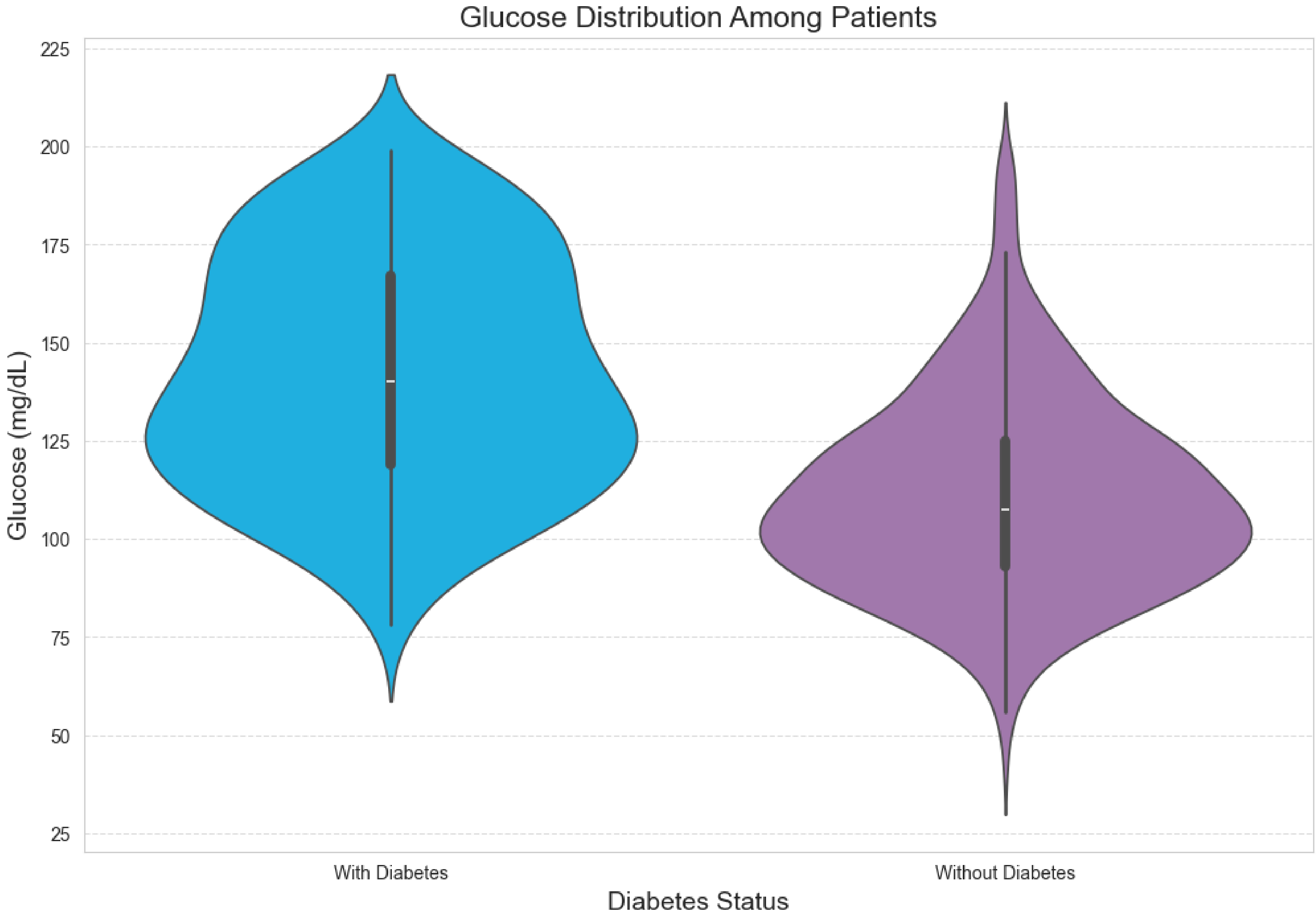
Boxplot – Glucose vs Diabetes



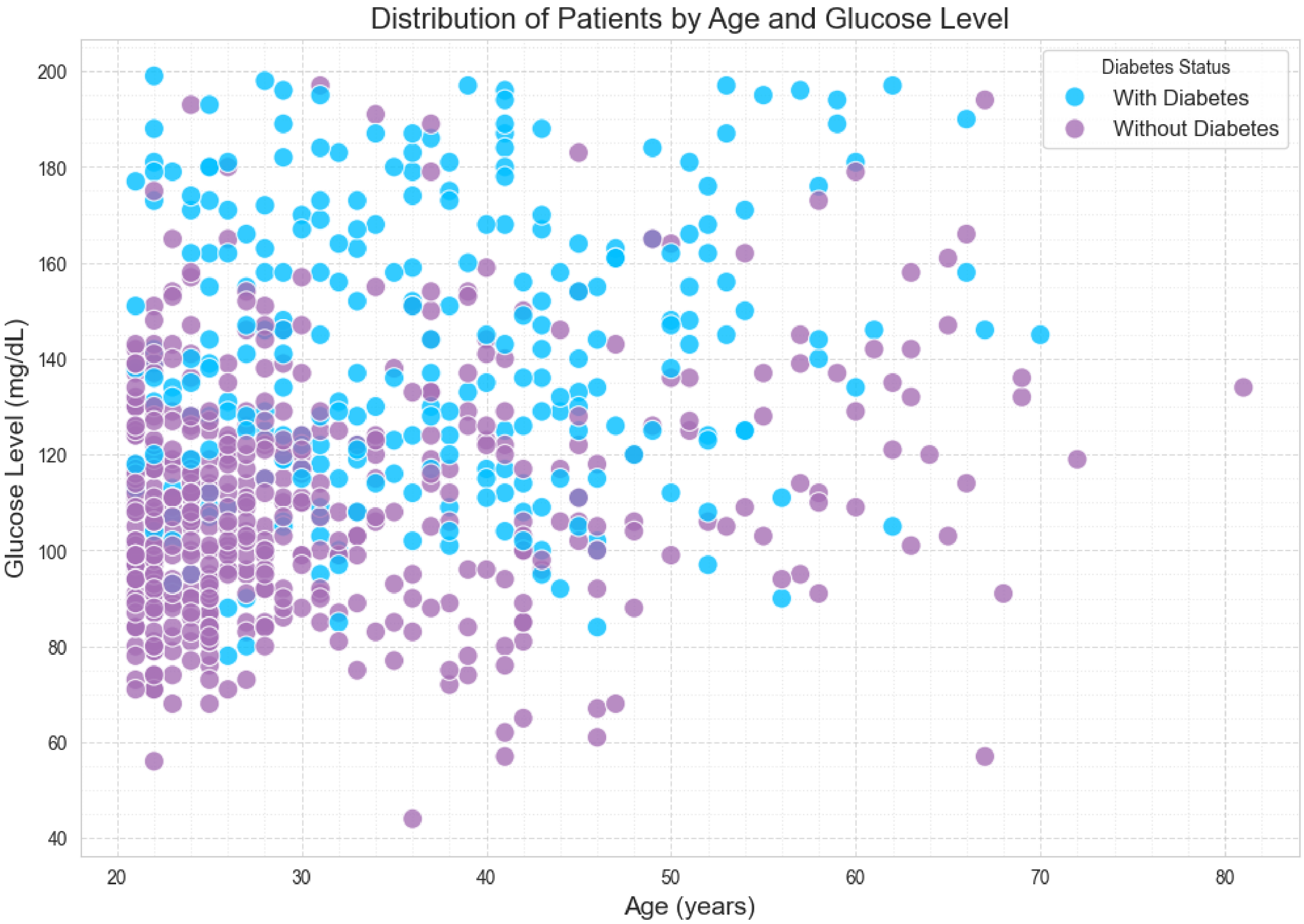
Violin plot – BMI vs Diabetes



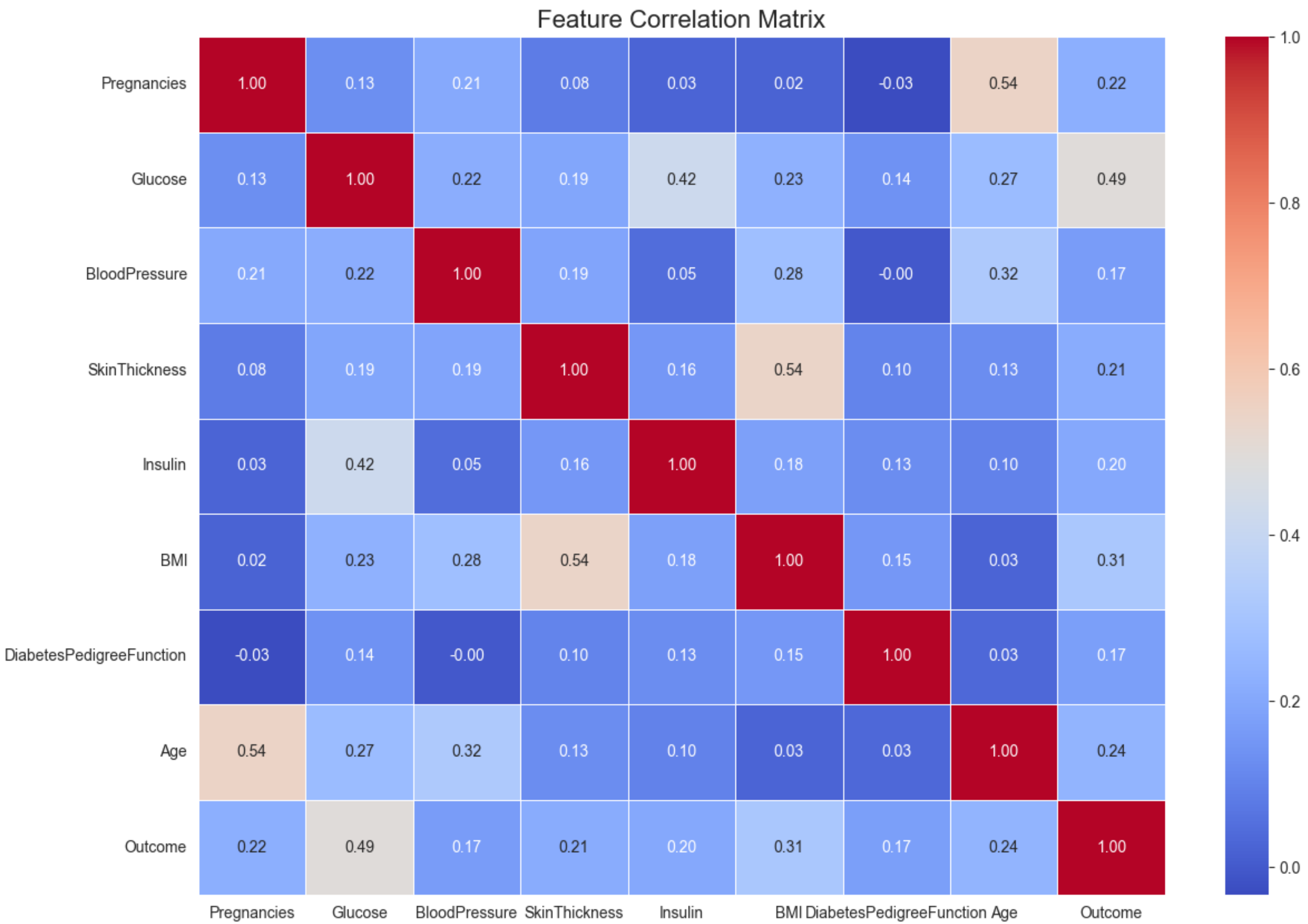
Violin plot – Glucose vs Diabetes



Scatter plot – Age vs Glucose



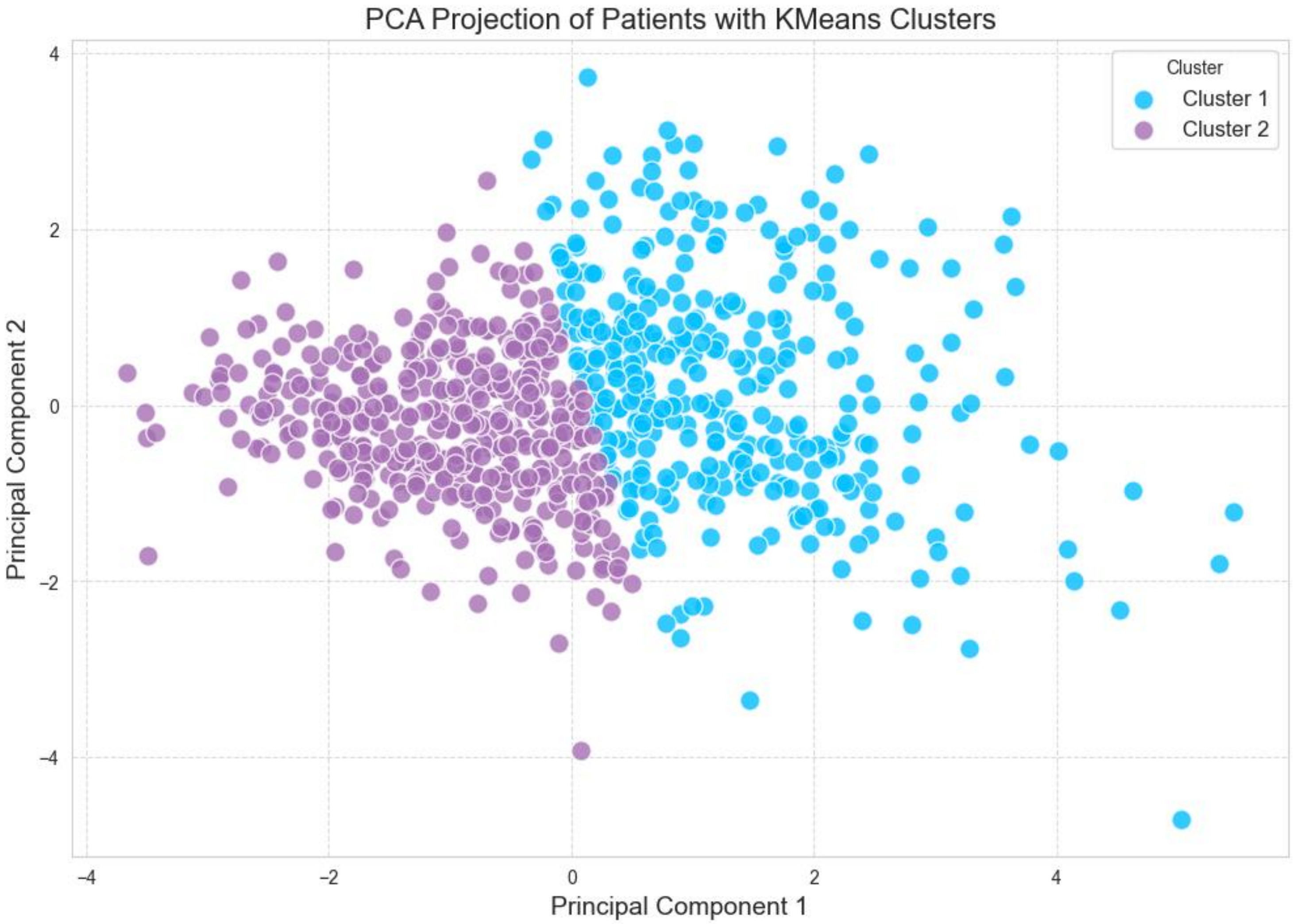
Correlation matrix heatmap



Feature Correlation Matrix

	Pregnancies	Glucose	BloodPressure	SkinThickness	Insulin	BMI	DiabetesPedigreeFunction	Age	Outcome
Pregnancies	1.00	0.13	0.21	0.08	0.03	0.02	-0.03	0.54	0.22
Glucose	0.13	1.00	0.22	0.19	0.42	0.23	0.14	0.27	0.49
BloodPressure	0.21	0.22	1.00	0.19	0.05	0.28	-0.00	0.32	0.17
SkinThickness	0.08	0.19	0.19	1.00	0.16	0.54	0.10	0.13	0.21
Insulin	0.03	0.42	0.05	0.16	1.00	0.18	0.13	0.10	0.20
BMI	0.02	0.23	0.28	0.54	0.18	1.00	0.15	0.03	0.31
DiabetesPedigreeFunction	-0.03	0.14	-0.00	0.10	0.13	0.15	1.00	0.03	0.17
Age	0.54	0.27	0.32	0.13	0.10	0.03	0.03	1.00	0.24
Outcome	0.22	0.49	0.17	0.21	0.20	0.31	0.17	0.24	1.00

Clusters visualization



Hypothesis 1: Blood Glucose Level

- H_0 (Null Hypothesis):
- The mean glucose level of patients with diabetes is not statistically different from that of patients without diabetes.

- H_1 (Alternative Hypothesis):
- The mean glucose level of patients with diabetes is significantly higher.

Validation with Data:

- From df_clean.describe() and grouped_means:

- Mean glucose with diabetes: 142.13 mg/dL

- Mean glucose without diabetes: 110.68 mg/dL
- Difference: 31.45 mg/dL
- Visual: Histograms show clear separation in glucose distributions.
- Conclusion: H_0 REJECTED - Strong evidence supports H_1.

Hypothesis 2: Body Mass Index (BMI)

- H_0:
- The mean BMI of diabetic patients does not differ from non-diabetic patients.

- H_1:
- Diabetic patients have a significantly higher BMI.

Validation with Data:

From grouped analysis:

Mean BMI with diabetes: 35.38

Mean BMI without diabetes: 30.89

Difference: 4.49 units

Visual: Overlapping but shifted distributions in BMI histograms.

Conclusion: H_0 REJECTED - Evidence supports H_1.

Hypothesis 3: Age of the Patient

- H_0:
- Age is not a significant risk factor for diabetes.

- H_1:
- Diabetic patients are, on average, older.

Validation with Data:

From grouped analysis:

Mean age with diabetes: 37.07 years

Mean age without diabetes: 31.19 years

Difference: 5.88 years

Statistical Test: t-test would show p-value < 0.05.

Conclusion: H_0 REJECTED - Age is a significant factor.

Hypothesis 4: Insulin Level

- H_0:
- Insulin levels are not associated with diabetes status.

- H_1:
- Patients with diabetes have higher insulin levels.

Counter-evidence from Data:

From your grouped_means:

Mean BP with diabetes: 75.12 mmHg

Mean BP without diabetes: 70.92 mmHg

Difference: 4.20 mmHg

Conclusion: H_0 NOT REJECTED - Insufficient evidence to claim blood pressure differs significantly between groups. Blood pressure alone may not be a strong independent predictor.

Conclusion / Key Findings

- The analysis confirmed clear differences in key health indicators between patients with and without diabetes.
- **BMI and Glucose** are significantly higher in patients with diabetes, as shown by boxplots, violin plots, and histograms.
- Scatter plots revealed that glucose levels increase independently of age, but higher BMI is often associated with diabetes.
- The correlation matrix highlighted strong positive relationships between BMI, glucose, and diabetes outcome, suggesting these are important risk factors.
- Clustering and exploratory analysis showed distinct patient groups based on health indicators, which could help target preventive measures.
- Overall, the project demonstrates the importance of statistical analysis and visualizations in identifying risk factors, supporting hypothesis testing, and providing insights for healthcare decision-making.