TECHNICAL REPORT

Heart Attack: Cardiac Risk Assessment

Outlines

Introduction

Heart disease remains a leading cause of mortality globally, and leveraging data for timely detection is more critical than ever.This project explores the use of data in identifying and understanding key factors associated with heart attacks. By examining a clinical dataset with Power BI, the objective is to uncover meaningful patterns that can aid in early diagnosis and effective prevention strategies.

This report presents a comprehensive analytical approach that combines demographic, physiological, and biochemical indicators—such as age, gender, blood pressure, blood sugar, CK-MB, and troponin levels—to evaluate patients' cardiac risk profiles. The outcome is an interactive dashboard that enables healthcare professionals and decision-makers to derive actionable insights, improve screening processes, and prioritize patient care based on data-driven evidence.

Story of the Data

The dataset used in this analysis provides clinical and demographic information on **1,319 patients**, each evaluated for heart-related risk factors and outcomes. The data

was downloaded from kaggle.com. and is structured to support both diagnostic assessment and research.

Each record in the dataset represents an individual patient and includes variables such as **Age**, **Gender**, **Heart Rate**, **Systolic and Diastolic Blood Pressure**, **Blood Sugar**, **CK-MB levels**, **Troponin levels**, and the final diagnosis labeled as **Result** (indicating whether or not the patient had a heart attack).

The dataset contains both **quantitative variables** (like blood pressure readings, troponin levels, and heart rate) and **categorical variables** (such as gender and result). To facilitate better segmentation, an **Age Group** column was created to classify patients into **Young**, **Adult**, and **Old**, while Gender values were mapped from binary (0,1) to descriptive labels (Female, Male). Additionally, a **Blood Pressure Classification** column was introduced to categorize patients as having either **Normal BP** or **High BP** based on clinical thresholds.

This structured dataset offers a rich foundation for exploring the relationships between vital signs and the likelihood of heart attack. By analyzing this information visually and statistically, the goal is to uncover insights that can aid in **early detection**, **risk stratification**, and **preventive intervention** strategies for heart disease.

Data Preprocessing

Before meaningful analysis and visualization could take place, several preprocessing steps were performed to ensure the dataset was clean, organized, and ready for use in Power BI.

1. Data Cleaning

- **Missing Values**: The dataset was reviewed for missing or null values. No critical fields were found missing, so all rows were retained for analysis.

- **Data Types**: Data types were verified and corrected where necessary. For instance, numeric fields like *Heart Rate*, *Blood Pressure*, *Blood Sugar*, *CK-MB*,

and *Troponin* were ensured to be recognized as numerical data types for proper aggregations and visualizations.

2. Feature Engineering

To improve interpretability and enable meaningful analysis, new columns were added:

- **Age Grouping**:
  A new column grouped patients into:
  - *Young*: Age < 40
  - *Adult*: Age 40–59
  - *Old*: Age ≥ 60
    This helped analyze trends across different life stages.

- **Gender Labeling**:
  The original Gender column used binary values:
  - *0* = Female
  - *1* = Male
    These were converted into readable labels to enhance clarity in visualizations.

- **Blood Pressure Category**:
  Using both Systolic and Diastolic readings, patients were categorized as:
  - *Normal BP*: Systolic < 140 AND Diastolic < 90

- *High BP*: Systolic ≥ 140 OR Diastolic ≥ 90
  This allowed classification of patients' blood pressure risk level.

- **Patient ID Creation**:
  A custom column was added to assign each patient a unique identifier with a prefix, e.g., `PAT-001`, `PAT-002`, etc., to support individual-level tracking and maintain anonymity.

📊 3. Data Structuring in Power BI

- The cleaned and enriched dataset was loaded into Power BI's data model.

- Measures and calculated columns were created using DAX to enable dynamic metrics.

- Slicers were implemented for Gender and Age Group to support user-driven filtering across visuals.

This preprocessing phase transformed raw clinical data into an analysis-ready structure, setting the foundation for meaningful insights and storytelling through visuals.

Pre Analysis

Objectives

- Identify Key Risk Factors associated with heart attack outcomes using patient clinical data.
- Classify patients into age and risk groups to analyze demographic trends in heart attack occurrence.

- Visualize patterns in vital signs and biochemical markers (e.g., heart rate, blood pressure, troponin).

- Compare heart attack rates across genders and age groups.
- Support early detection by flagging high-risk profiles based on a combination of medical indicators.

Key Metrics and Dimensions

Metrics (Quantitative Measures):

- Total number of patients
- Number of confirmed heart attack cases
- Heart attack rate (%)
- Average heart rate, blood pressure, blood sugar
- Average Troponin and CK-MB levels
- Number of patients in each risk group (e.g., High Risk, Normal)

Dimensions (Categories to Slice/Filter Data):

- **Age group**: Young, Adult, Old
- **Gender**: Male, Female
- **Heart attack status**: Heart Attack / No Heart Attack
- **Blood pressure category**: Normal BP / High BP
- **Risk flag**: High Risk / Normal
- **Patient ID**: for tracking individual records

Potential Challenges and Limitations

- **Binary Gender Representation**: Only coded as 0/1 (likely Male/Female), excludes non-binary data.
- **No timestamps or date fields**: Limits trend or time-series analysis.
- **No lifestyle or history data**: Important factors like smoking, cholesterol, or exercise aren't included.
- **Troponin/CK-MB threshold interpretation**: Requires domain expertise to define clinically meaningful cutoffs.
- **Small or synthetic dataset risk**: May not represent a large or diverse patient population, which can limit generalizability.
- **Missing context for "Result"**: Assumes 0 = No Heart Attack and 1 = Heart Attack, but needs confirmation.
- **No unique patient traits** beyond numerical data: Limits behavioral or psychological analysis.

In Analysis

- A total of 1,319 patients were analyzed; Out of these, 810 patients (61%) tested positive for heart attack, while 509 (39%) were negative.
- Based on the sum of diastolic blood pressure, 61% of the total pressure is attributed to patients with heart attacks, while 38% is from those without.
- The dataset includes 870 male and 449 female patients, showing a higher representation of males.

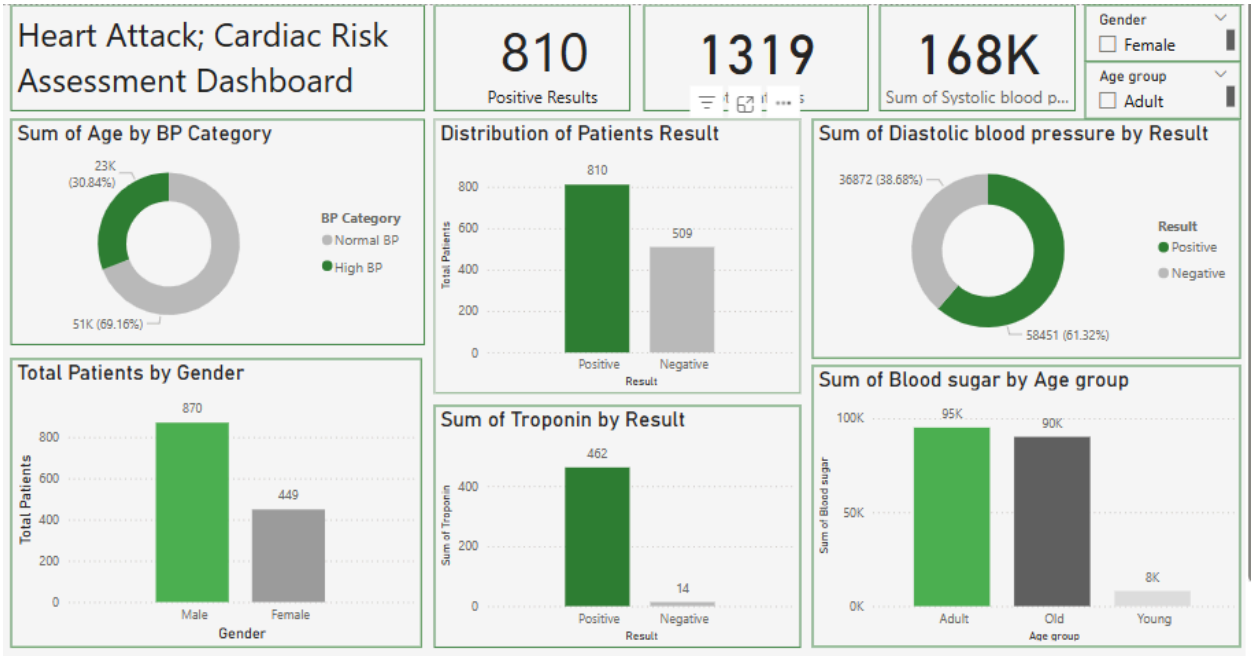
- Adults have the highest total blood sugar levels, followed by the old, then the young age group.
- 70% of patients have normal blood pressure, while 30% show high blood pressure values.

Recommendations

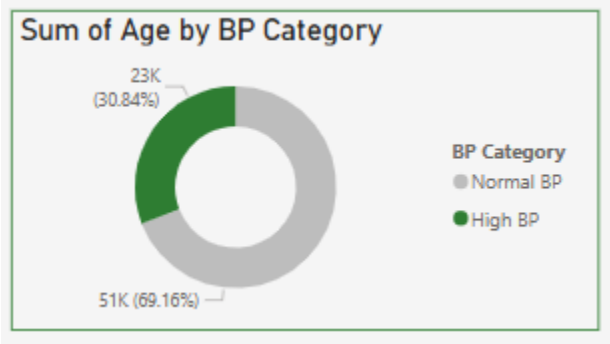
- **Target Adult Group for Preventive Measures**: Since adults show the highest blood sugar levels — a potential risk factor — focus on early detection and lifestyle interventions for this group.
- **Prioritize Male Patients in Outreach**: With significantly more male patients and higher heart attack rates, awareness campaigns could be tailored to men in high-risk categories.
- **Monitor High Blood Pressure Patients Closely**: While most patients have normal BP, the **30% with elevated BP** should be prioritized for follow-up, as high BP is a strong heart attack risk factor.
- **Further Investigate Diastolic Pressure Impact**: The strong presence of elevated diastolic pressure among positive cases suggests a need for deeper analysis on how this variable influences heart attack occurrence.

Data Visualization and Charts

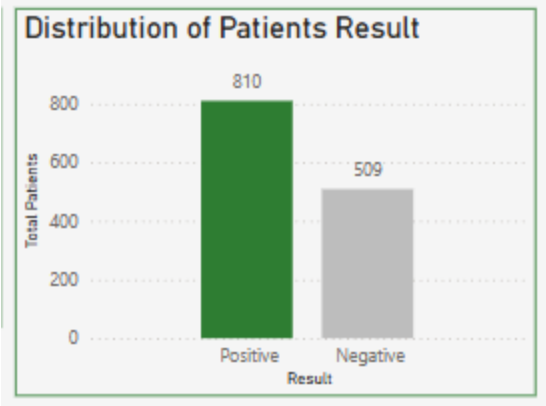
Dashboard



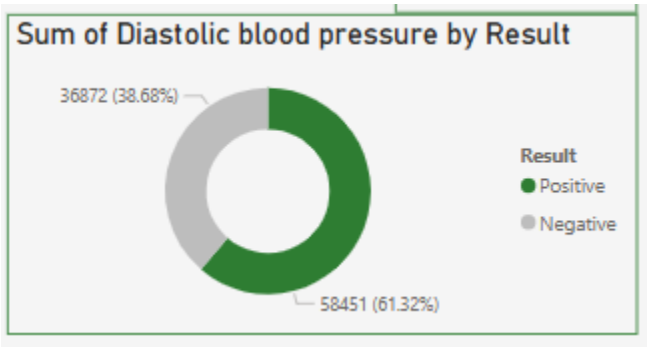
Key Visualizations



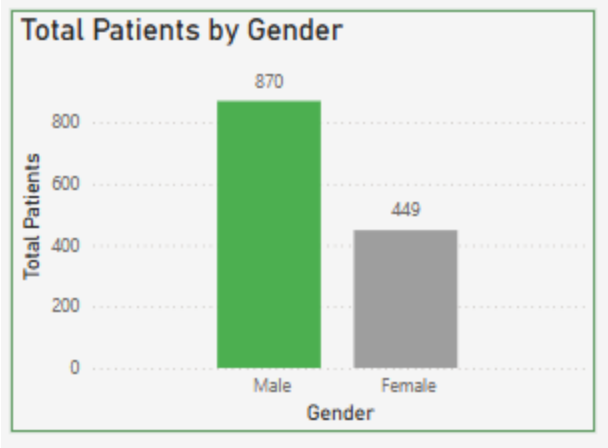
This is a doughnut chart and it is the first chart on the dashboard, this dashboard sums the age by BP category and 69% had normal while 30% had high blood pressure.



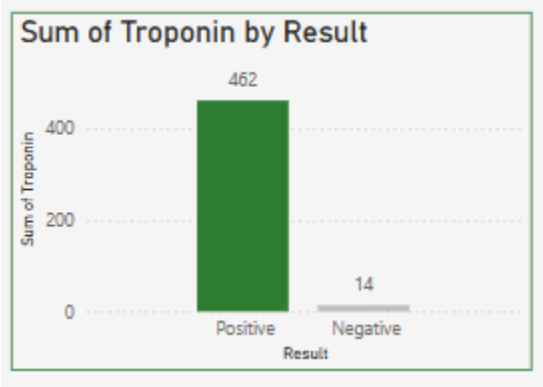
This the second chart on the dashboard and it visualizes the distribution of patients results, 810 patients results tested Positive for heart attack while 509 patients tested Negative.



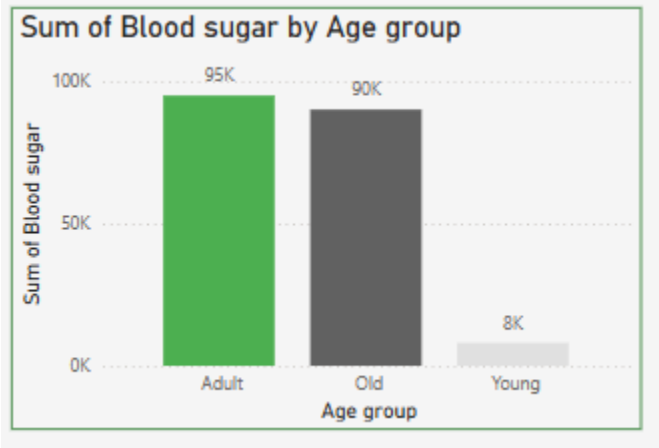
The sum of diagnostic blood pressure by result is visualized by a doughnut chart and the positive is 61% while the negative is 38%.



The gender of the patients is represented by a column chart and the male patients tops the chart with 870 patients, while the female patients recorded are 449.



The troponin result is represented on a column chart and the positive tops the chart in this case.



For the blood sugar by age group, the adult age group tops the chart followed by the Old age group and the young age group is the least indicating that the younger age group are in the normal range.

Observations

- **Adult Age Group:**
  - **Heart Attack Prevalence**: Out of 646 adults, 56% tested positive — a moderate but significant risk.
  - **Blood Pressure**: 68.62% have normal BP, suggesting that elevated BP is not the sole driver of cardiac risk in this group.
  - **Diastolic Pressure**: Nearly balanced between positive and negative cases, showing limited differentiation power for diagnosis in adults.
  - **Troponin**: Substantially higher in positive cases, reinforcing its value as an early diagnostic biomarker.
  - **Blood Sugar**: All blood sugar values originate from this age group under the current filter, pointing to **adult-onset metabolic risks** (possibly prediabetes or type 2 diabetes) that could be influencing cardiac health.
- **Old Age Group:**
  - **Data Volume**: 620 patients, with unusually high (810) positive results possibly indicating multiple entries or test records per patient.
  - **Blood Pressure**: 70% have high BP — hypertension is clearly more common and impactful in this age bracket.

- **Cardiac Indicators**: Elevated troponin levels and BP readings strongly align with positive cases, confirming heart attack risk.

- **Gender Distribution**: Males dominate this age group's dataset, potentially influencing the outcome patterns.

- **Blood Sugar**: High cumulative values further link **metabolic syndrome** with cardiac vulnerability in older adults.

Female Patients:

- **Heart Attack Rate**: 56% tested positive — notable but slightly lower than males.

- **Blood Pressure (BP)**: 70% of females have normal BP, suggesting BP alone isn't a strong predictor.

- **Diastolic BP**: Higher cumulative diastolic pressure in positive cases (55%) indicates a moderate link.

- **Troponin Levels**: Elevated troponin in positives (110 vs. 70 units) underscores its diagnostic value.

- **Blood Sugar by Age**: Adult females show the highest blood sugar levels, highlighting metabolic risk in this group.

Male Patients:

- **Heart Attack Rate**: 63% tested positive — a higher prevalence compared to females.

- **Blood Pressure (BP)**: 68.63% have normal BP — again pointing to multifactorial causes beyond BP.

- **Diastolic BP**: A significant 64.7% of diastolic total is from positive cases, indicating stronger correlation than in females.

- **Troponin Levels**: Very high troponin levels in positives — even more pronounced than in females.

- **Blood Sugar by Age**: Adult and older males show significantly elevated blood sugar, reinforcing age-related metabolic risk.

Recommendations

1. **Enhance Screening for Adults & Older Age Groups**:
   Prioritize regular heart health screenings for adult and elderly males and females, especially targeting blood sugar and diastolic BP.

2. **Use Troponin as a Primary Diagnostic Marker**:
   Both male and female data confirm troponin as a strong indicator — this should be central in clinical diagnostics for suspected heart attacks.

3. **BP Should Be Evaluated with Other Metrics**:
   Since many patients with normal BP still experienced heart attacks, clinicians should combine BP analysis with other variables (troponin, blood sugar, lifestyle factors).

4. **Implement Gender-Specific Risk Programs**:

    - For **females**, focus on diastolic pressure and metabolic risk in adult age groups.

    - For **males**, monitor both diastolic pressure and blood sugar more aggressively, particularly in adults and seniors.

5. **Preventive Health Education**:
   Educate patients — especially middle-aged adults — on lifestyle changes (diet, exercise, stress management) that mitigate blood sugar and cardiac risks.

6. **Data-Driven Personalized Care**:
   Encourage healthcare providers to adopt data-driven profiling of patients, using variables like age, gender, troponin, and BP to inform early interventions.

Conclusion

This project successfully leveraged Power BI to transform raw clinical data into actionable insights regarding heart attack risks across a population of 1,319 patients. Through thoughtful preprocessing, segmentation, and visualization, the analysis revealed several key trends: a high overall prevalence of heart attack cases, elevated risk among adult males and females with high blood sugar levels, and strong correlations between positive outcomes and biomarkers such as troponin and diastolic blood pressure.

One of the most important findings is that **normal blood pressure alone does not eliminate the risk of heart attack**. Many patients with seemingly healthy readings still tested positive, emphasizing the importance of multi-factor assessments. Troponin, in particular, emerged as a reliable indicator of heart attack risk, consistent across age and gender groups.

The dashboard empowers healthcare professionals to explore risk factors dynamically, filter by age and gender, and prioritize at-risk individuals for early intervention. Moving forward, this kind of data-driven approach can enhance diagnostic accuracy, guide preventive strategies, and ultimately contribute to improved cardiac health outcomes.