Associations of Healthcare Costs and Early Detection with Colorectal Cancer Mortality in the USA

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Introduction

Study Objective

Clearly define the research questions or objectives.

Dataset Overview

The dataset we decide to conduct our analysis of Mortality status (Alive/Dead) was sourced from Kaggle, which the dataset name is "Colorectal Cancer Global Dataset & Predictions". For the objective of this project, we only considered the data from Canada, which includes patient demographics, lifestyle risks, medical history, cancer stage, treatment types, survival chances, and healthcare costs. Key variables of we are going to investigate as follows:

Response variable:

Name	Description	Type
Mortality status	Status of patients' mortality (Yes/No)	Categorical, nominal

Explanatory variable:

Name	Description	Type
Alcohol Consumption	status of Patient's alcohol consumption (Yes/No)	Categorical, nominal
Age	Patient's age in years	Numerical, continuous
Cancer Stage	diagnosis of stage in cancer (Localized, Regional, Metastatic)	Categorical, ordinal
Diabetes	status of Patient's diabetes (Yes/No)	Categorical, nominal
Diet Risk	Level of risk based on dietary (Low, Moderate, High)	Categorical, ordinal
Early Detection	detection of colorectal cancer at an early stage (Yes/No)	Categorical, nominal
Family History	Presence of family history of colorectal cancer (Yes/No)	Categorical, nominal
Genetic Mutation	Presence of genetic mutations of colorectal cancer (Yes/No)	Categorical, nominal
Gender	Gender of the patient (Male/Female)	Categorical, nominal
Healthcare cost	Estimated healthcare expenditure per patient (1,000 units in $)	Numerical, continuous
Inflammatory Bowel Disease	Status of inflammatory bowel disease (Yes/No)	Categorical, nominal
Insurance Status	Health insurance coverage status (Insured, Uninsured)	Categorical, nominal
Obesity BMI	Classification based on Body Mass Index (Normal, Overweight, Obese)	Categorical, ordinal
Physical Activity	Physical activity level (Low, Moderate, High)	Categorical, ordinal
Screening History	History of cancer screening in 3 levels (Regular, Irregular, Never)	Categorical, ordinal
Smoking History	Patient's smoking history (Yes/No)	Categorical, nominal
Treatment Type	Type of treatment that patients received (Surgery, Chemotherapy, Radiotherapy, Combination)	Categorical, ordinal

Name	Description	Type
Tumor size	colorectal tumor measured in millimeters (mm)	Numerical, continuous
Urban or Rural	The type of patients area (Urban/ Rural)	Categorical, nominal

Motivation

- Why is this question or data important/interesting?
- Need to explain why we remove country-level variable and Patient_ID, reasonable is fine.

Analysis

Exploratory Data Analysis (EDA)

Balance of Response Variable

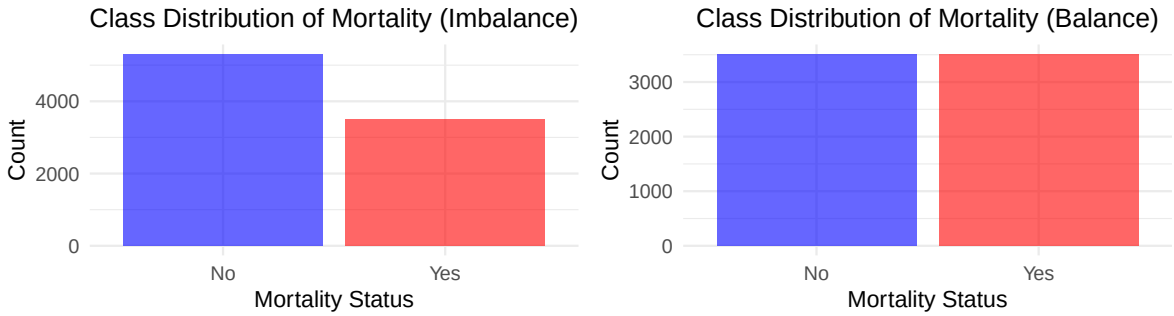

Figure 1: Class Distribution of the Mortality Variable Before and After Balancing

Continuous Variables

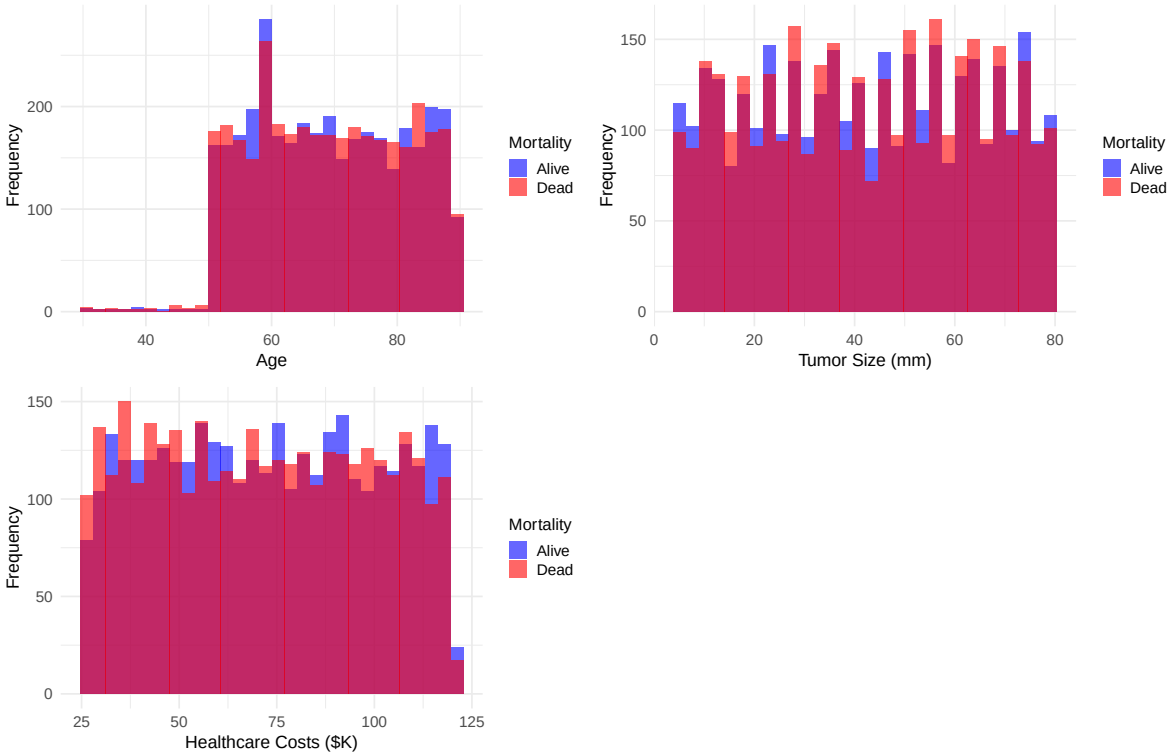

Figure 2: Distribution of continuous variables by mortality status

Categorical Variables

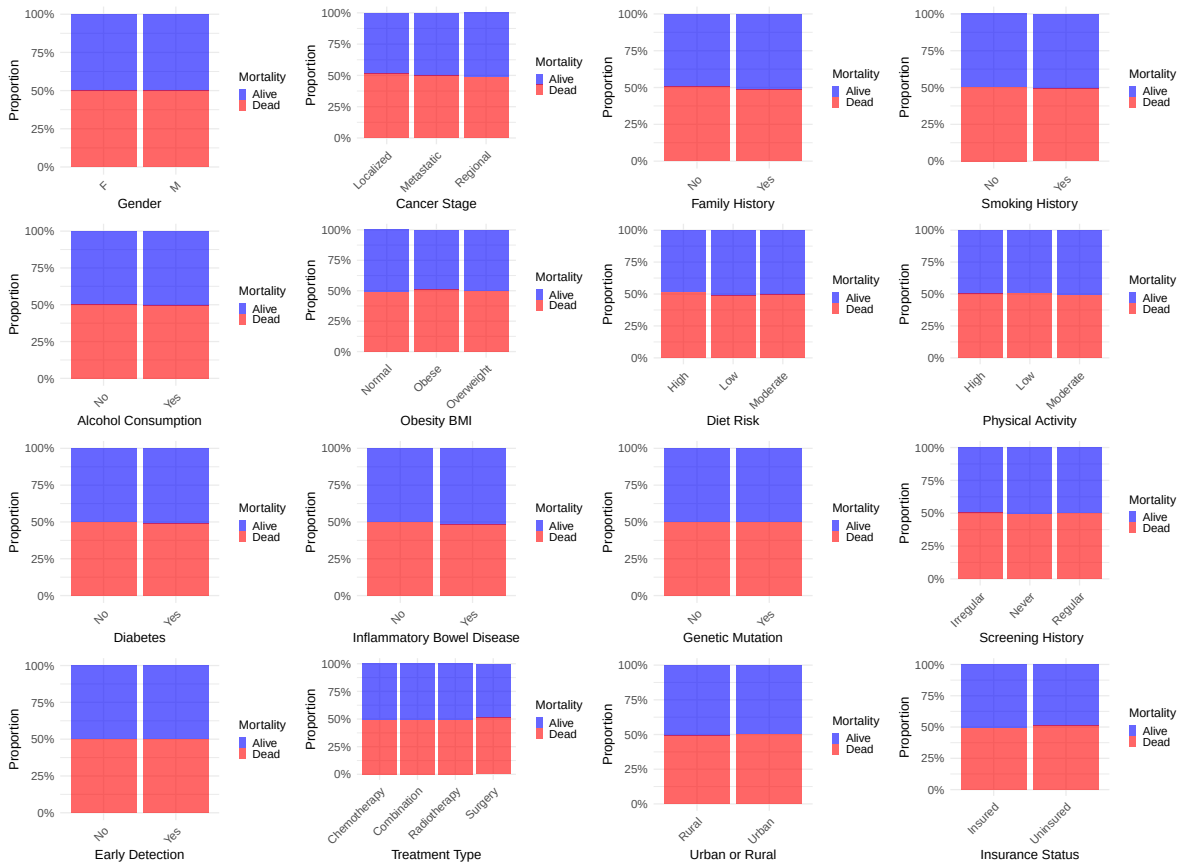

Figure 3: Proportion Bar plots for Categorical variables by mortality status

Interpretation of Findings

Pattern, trends, suggested operations

Model Choice and Reasoning

Logistic Regression

explain why choose this model based on EDA and Data description

Assumption Check

1. **Binary Response**

   Based on *Figure 1* , the response variable is binary

2. **Independence**

   No duplicate rows, independence hold

3. **Variance Structure**

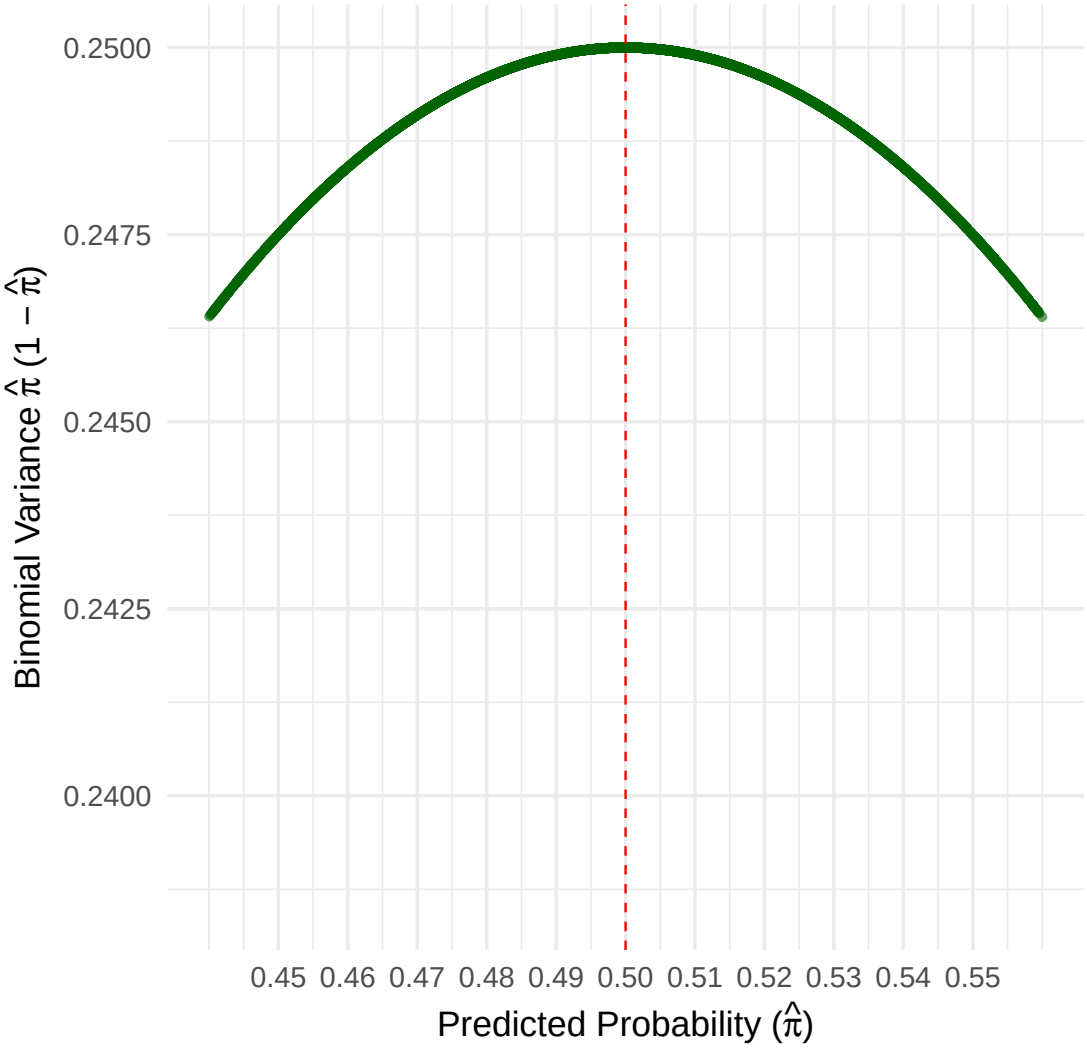

Figure 4: Variance peaks at predicted probability = 0.5.

4. **Linearity**

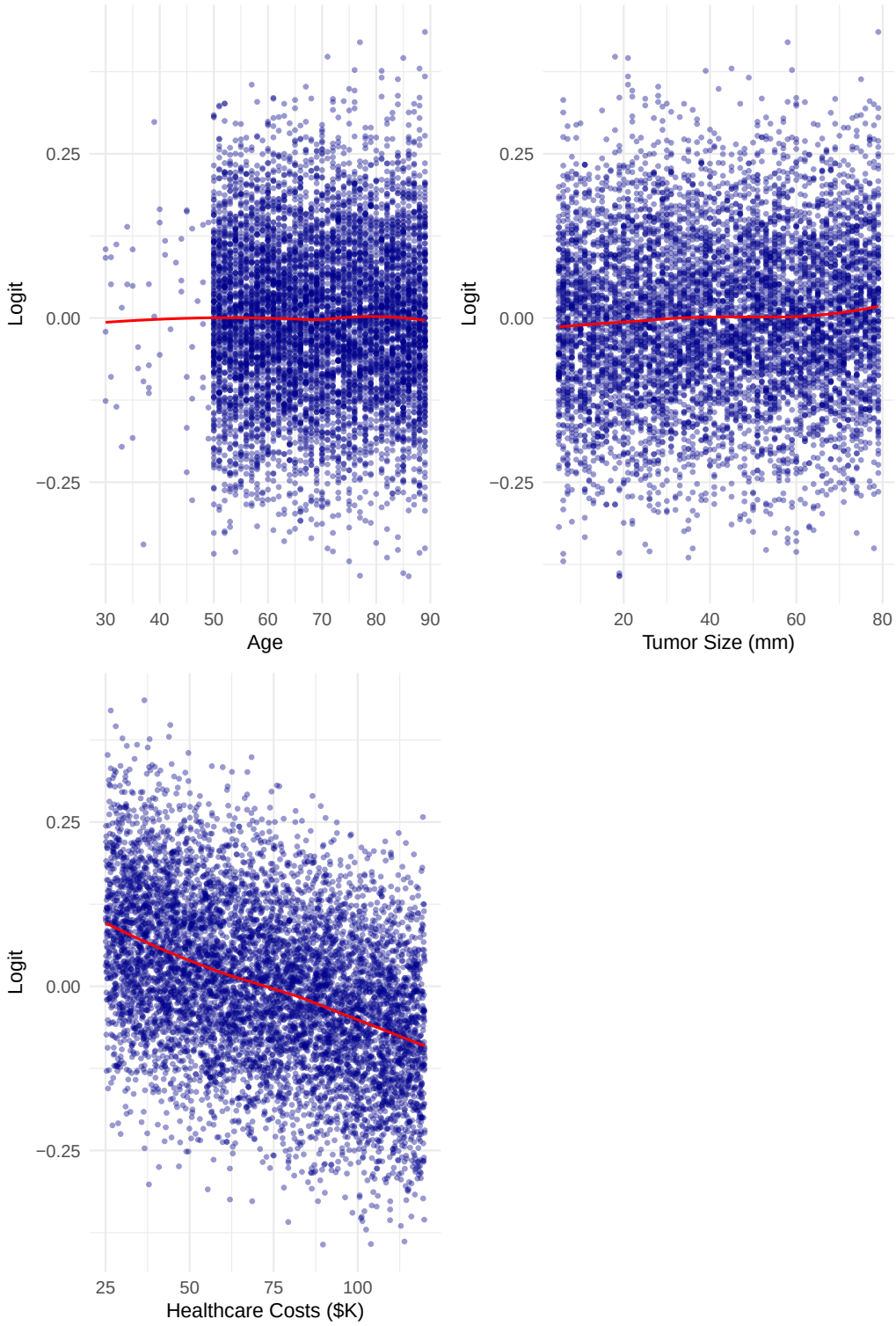

Figure 5: Linearity check − logit of mortality plotted against continuous variables

Feature Selection

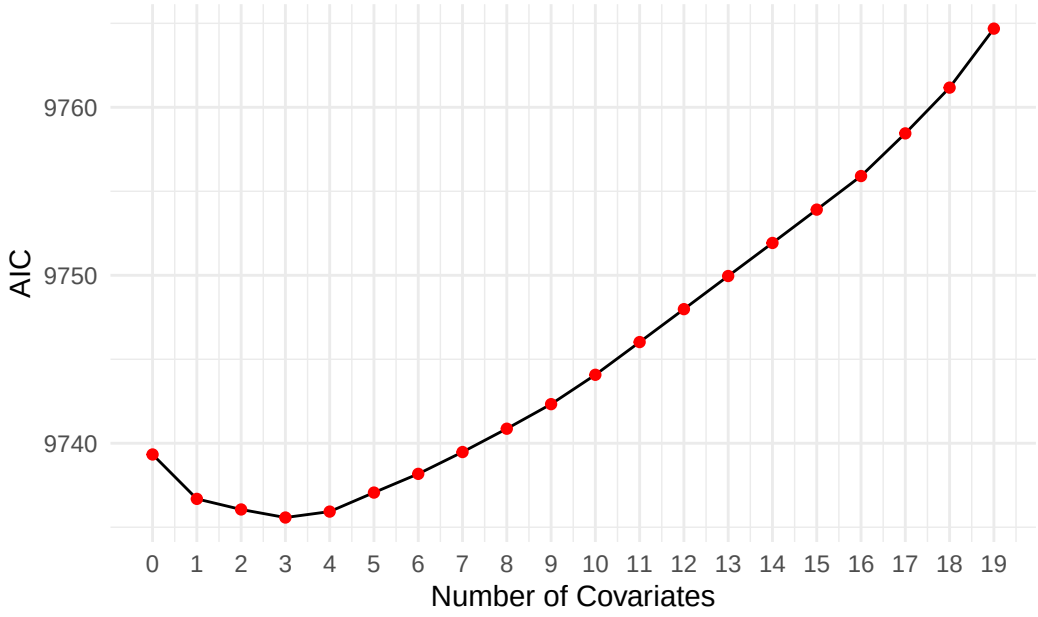

Figure 6: AIC vs Number of Covariates − demonstrating backward feature selection.

```
Call:
glm(formula = Mortality ~ Cancer_Stage + Family_History + Healthcare_Costs,
    family = binomial, data = balanced_data)

Coefficients:
                          Estimate Std. Error z value Pr(>|z|)
(Intercept)              0.2209489  0.0753360   2.933  0.00336 **
Cancer_StageMetastatic -0.0707645  0.0648029  -1.092  0.27484
Cancer_StageRegional   -0.1152779  0.0537357  -2.145  0.03193 *
Family_HistoryYes      -0.0818704  0.0520016  -1.574  0.11540
Healthcare_Costs       -0.0018629  0.0008734  -2.133  0.03294 *
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 9737.3  on 7023  degrees of freedom
Residual deviance: 9725.6  on 7019  degrees of freedom
AIC: 9735.6
```

```
Number of Fisher Scoring iterations: 3
```

Statistical Analysis

```
Call:
glm(formula = Mortality ~ Cancer_Stage + Family_History + Healthcare_Costs +
    Early_Detection, family = binomial, data = balanced_data)

Coefficients:
                         Estimate Std. Error z value Pr(>|z|)
(Intercept)             0.2256713  0.0804475   2.805  0.00503 **
Cancer_StageMetastatic -0.0707315  0.0648033  -1.091  0.27506
Cancer_StageRegional   -0.1151017  0.0537461  -2.142  0.03223 *
Family_HistoryYes      -0.0817314  0.0520083  -1.572  0.11607
Healthcare_Costs       -0.0018622  0.0008735  -2.132  0.03301 *
Early_DetectionYes     -0.0081611  0.0487565  -0.167  0.86707
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 9737.3  on 7023  degrees of freedom
Residual deviance: 9725.5  on 7018  degrees of freedom
AIC: 9737.5

Number of Fisher Scoring iterations: 3
```

Results Interpretation

inference results

Conclusion

Main Findings

Interpreting result in real-world context, careful about causality

Limitations

- Discuss possible sources of bias, limitations in data, model assumptions
- Suggest improvements or next steps

Potential Further research

Mention anything interesting you found that doesn't fit elsewhere

Appendix

- Full regression output
- Extra plots or tables not essential to the main body
- Model selection steps