Faculty of Natural and Mathematical Sciences
Department of Informatics

King's College London Strand Campus, London, United Kingdom



#### 7CCSMPRJ

### Individual Project Submission 2024 - 2025

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Degree Programme: MSc. Advanced Computing

Project Title: GluCORRECT - Harnessing Artificial Intelligence to

scrutinize Hypoglycemia in hospitalised patients with

diabetes to classify, anticipate and analyse hypoglycemic

episodes [Knowledge Exchange Project with NHS England]

**Supervisor:** Dr. Rita Borgo

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Signature: Signature Date: August 5, 2025



## Department of Informatics King's College London United Kingdom

7CCSMPRJ Individual Project

GluCORRECT - Harnessing Artificial
Intelligence to scrutinize Hypoglycemia in
hospitalised patients with diabetes to classify,
anticipate and analyse hypoglycemic episodes
[Knowledge Exchange Project with NHS
England]

Name: **Siddharth Kishor Samarth** Student Number: K24012370 Course: MSc. Advanced Computing

Supervisor: Dr. Rita Borgo

This dissertation is submitted for the degree of MSc Advanced Computing.

# Acknowledgements

I would like to express my sincerest gratitude towards my project supervisor, Dr. Rita Borgo, for her invaluable advice and consistent direction throughout the course of this project. Her mentorship and ideas have been instrumental in shaping the development of this work, leading to its successful completion.

I am also deeply thankful & appreciative of my industry advisor, Dr. Piya Sen Gupta, for providing the dataset that has served as the foundation of this work. Her contributions have significantly enhanced the practical relevance and quality of this project.

Ultimately I would like to thank my friends and my parents, especially my dad, without whose sacrifices I would not be where I am today.

### Abstract

<u>Project Variant:</u> Variant 4 - Develop a weighted score and design score to predict risk of a hypoglycaemic episode before it occurs.

It is well known that hypoglycemia as well as hyperglycemia are common adverse events in patients who receive blood sugar control medication, and they are also one of the most frequently cited causes of hospital admissions in people with diabetes. National quality improvement programmes from the Healthcare Quality Improvement Partnership (HQIP) and the study of ambulance call-out data have shown that lack of awareness by both affected individuals and their attendants is associated with a dramatically increased rate of complications, amongst other factors. Guy's & St. Thomas' NHS Foundation Trust (hereafter referred to as GSTT) has found, after careful deliberation and departmental review, that hypoglycemic episodes have been occurring with unusual frequency. The Trust now seeks to take measures to resolve such problems with a greater focus on prevention combined with early corrective action. This research project has been undertaken in close collaboration with GSTT, one of the largest NHS trusts in the UK and an indispensable element of London's healthcare system, with almost 24000 staff across 5 major hospitals, handling over 3 million patients a year and generating an annual turnover of over £3 billion.

This analytical study serves as a foundation and proof-of-concept to aid GSTT in preemptively reducing hypoglycemia within hospitalised inpatients, by utilising statistics & machine learning techniques. Through exploratory data analysis I draw out relevant conclusions about the dataset around patient age, ethnicity and

I go on to identify the significant factors responsible for hypoglycemia within the dataset provided by the industry advisor from GSTT through exploratory data analysis, while also . I explore how they can be utilized to devise a risk score, to classify patients based on their risk of hypoglycemia.

RESULTS: HbA1c values identified as risky - 56 or so eGFR ethnicity major is glucose value

In conclusion, exhibit my findings with potential ways of applying them in practise in hospitals.

All abbreviations and symbols used in the report must be listed and defined in alphabetic order.

### Nomenclature

GSTT Guy's and St Thomas' NHS Foundation Trust HQIP Healthcare Quality Improvement Partnership

"Hypo" or "Hypos" Hypoglycemic episode(s)

"Inpatient" Referring to the the fact that a patient is required to stay overnight

in order to be treated (in case of surgeries or long term observation for example)

NCAPOP National Clincal Audit & Patient Outcomes Programme

NDA National Database Audit

NDISA National Diabetes Inpatient Safety Audit

NHS The publicly funded healthcare system of the United Kingdom,

the National Health Service.

a The number of angels per unit area

A The area of the needle point

c Speed of light in a vacuum inertial frame

h Planck constant

LMI Linear Matrix Inequalities

N The number of angels per needle point

# Contents

| 1  | Introduction                                   | 1         |
|----|--|-----------|
|    | 1.1 Clinical Overview                          | 1         |
|    | 1.2 Background                                 | 1         |
|    | 1.3 Aims and Objectives                        | 3         |
|    | 1.4 Report Structure                           | 3         |
|    | 1.4.1 Dissertation Length                      | 4         |
| 2  | Literature Survey & Review                     | 5         |
| 3  | Dataset  | 6         |
| 4  | Objectives, Specification and Design           | 8         |
| 5  | Methodology and Implementation                 | 8         |
| 6  | Results, Analysis and Evaluation               | 8         |
| 7  | Legal, Social, Ethical and Professional Issues | 8         |
| 8  | Others   | 9         |
|    | 8.1 Maths                                      | 9         |
|    | 8.2 Glossary and acronyms                      | 9         |
|    | 8.3 Figures                                    | 9         |
|    | 8.4 Table                                      | 10        |
| 9  | More Others                                    | 11        |
|    | 9.1 What is calibration?                       | 11        |
|    | 9.2 Numerical methods for calibration          | 11        |
| 10 | O Conclusion                                   | <b>12</b> |
| Re | eferences                                      | 13        |
| A  | Appendix                                       | 15        |
|    | A.1. Dataset                                   | 15        |

# List of Figures

| 1               | This is the caption for the figure                           |
|-----------------|--|
| 2               | This is the caption for the figure which is not even present |
| 3               | Another caption  |
| 4               | Raw dataset  |
| 5               | Dataset with cleaned features                                |
| $\mathbf{List}$ | of Tables  |
| 1               | Random data for a table                                      |

### 1 Introduction

#### 1.1 Clinical Overview

Hypoglycaemia (also known as a "hypoglycaemic episode" or a "hypo" for short) is the condition that occurs when the human body's blood glucose (sugar) level drops below the normal healthy range of 4.0 to 6.0 mmol/L. While it can affect anyone, it is most common in diabetic individuals who are prescribed drugs like insulin or metformin to inhibit glucose. Hypoglycaemic events are relatively simple and straightforward to resolve, but they need to be treated immediately to avoid serious damage to the brain and heart as a result of loss of consciousness or arrhythmias. High-sugar consumables are generally effective in correcting mild cases and are commonly recommended for immediate treatment, but severe cases of hypoglycaemia such as when the person is unconscious or having a seizure can only be resolved with an urgent, immediate glucagon injection to prevent them from deteriorating into a coma (or in rare cases, even leading to death).

To underscore how and why this matters, diabetes is one of the most significant and expensive long-term health conditions faced by the NHS, with recent figures from Diabetes UK suggesting that over 5.8 million people in the UK are living with diabetes, regardless of a formal diagnosis. It is estimated to cost the NHS over £10.7 billion a year, approximately 10% of its entire annual budget, which could go up to £18 billion by 2035 [1]. A stark finding is that almost 60% of this cost (around £6.2 billion) is spent on treating the largely preventable complications of diabetes, such as heart attacks, strokes, blindness, and so on, including hypoglycaemia [2]. Hypoglycaemic instances make up a major component of these preventable costs, mainly accounting for the emergency, ambulance, and acute care expenses associated with diabetes. The Local Impact of Hypoglycaemia Tool (LIHT) suggests that hypoglycaemia can cost up to £2,195 per episode, possibly increasing substantially with a longer stay in hospital [3], and it is estimated that there are up to 100,000 ambulance callouts annually according to the Diabetes Research and Wellness Foundation (DRWF) [4]. DRWF's study hinted that 1 in 10 individuals that experience a severe hypo (meaning requiring medical intervention or resuscitation) have considerable chances of another one within a fortnight.

### 1.2 Background

After introspective analysis supported by information from the National Diabetes Inpatient Safety Audit (NDISA) it has been recognized that severe hypoglycaemia and recurrent severe hypoglycaemia have been occurring relatively frequently across GSTT medical facilities. The NDISA forms part of the National Diabetes Audit (NDA), and it maintains that "The prevalence of diabetes continues to increase. In England

1.2 Background 2

between 2017-18 and 2021-22 prevalence of type 1 diabetes went up from 248,240 to 270,935 and the prevalence of type 2 and other diabetes from 2,952,695 to 3,336,980", as of 2022 [5].

GSTT administers upwards of 500,000 point-of-care glucose tests (POCT) annually, in addition to kidney function and glycated haemoglobin (HbA1c) tests as well. The Trust also possesses blood glucose / ketone data with additional linked data including demographics, dates of admission and discharge, patient as well as family history and current or previous medications. They have two major kinds of patient records, inpatient records for patients that have to stay over the course of one or multiple nights (for example, in case of surgeries or for long term care), and outpatient records where the patient doesn't require overnight stay. The Trust manages all of this data through their electronic health record management system called Epic, and facilitates patient access to their own records through the MyChart web application.

Hypoglycaemia is a frequent complication amongst inpatients having complex health conditions, especially within those in intensive care settings that have been / are critically ill due to advanced diseases or comorbidities, or in patients following major surgical interventions. The Trust is undertaking proactive measures to identify and mitigate the risk of hypoglycaemic episodes at an early stage, to support better planning, reduce healthcare costs, efficiently allocate hospital resources and also schedule operations optimally. The ideal way to assess risk would along the lines of developing tools to predict individualized risk scores for inpatients after considering all relevant factors. However, this presents a herculean task due to the sheer volume and complexity of factors involved, compounded by the challenges of producing reliable results even within small populations — such as those in remote areas — while also adhering to legal and governmental regulations:

- 1. Weighing up the risk of hypoglycaemia depends upon numerous aspects such as lifestyle, renal function, recent food intake, blood glucose history and current medication to name a few, making this a highly complicated modelling problem. In addition to this, patients differ widely in age, comorbidities, ethnic factors and even insulin sensitivity. This variability makes it a formidable challenge to develop a model that is generalizable, dependable and unbiased.
- 2. Any such analytical tool in the vicinity of patient healthcare requires medical evaluation and approval, validation trials, governance oversight as well as ethical considerations. Even a good model may fail if it does not fit the clinical workflow. Initial skepticism towards AI, the effort required to train staff, defining clear responsibilities and limits of liability, and rehearing procedures or plans of action for every possible scenario will all produce appreciable organizational inertia.

Successfully implementing even a small-scale solution, within GSTT to begin with, would be a significant strategic breakthrough that serves as a foundational model which other

NHS trusts or institutions could adapt and build upon. This positions this research initiative which is a Knowledge Exchange Project (KEP) with Guy's & St.Thomas' NHS Foundation Trust, an indispensable constituent of London's healthcare system, as a valuable and worthwhile research endeavour.

### 1.3 Aims and Objectives

This research project has the following objectives:

- To extract insights from provided dataset for the given time period and population. GSTT has expressed a strong interest towards gaining a deeper understanding of their inpatient population. The dataset they have provided includes demographic details, length of hospital stay, and ward information in addition to the main clinically relevant variables such as glycated haemoglobin levels, renal function measurements, patient age and so on. This enables a comprehensive, multifaceted analysis. The knowledge gained from this study, such as identifying which hospital wards have more vulnerable or at-risk patients, will be used to enhance staff training, in turn improving both future admissions routines as well as post-discharge support for patients. Every observation, regardless of scale, holds potential to refine hospital processes and operating procedures.
- To identify the main influencing / contributing factors for hypoglycaemia and develop a weighted risk score to predict episodes (Variant 4 KEP). The Trust is establishing and implementing measures to "pre-assess" inpatients to evaluate their risk of a hypoglycaemic episode, which will allow medical professionals to design protocols and policies to prevent episodes from occurring as well as take early remediative action as soon as possible to resolve an episode should it occur. I aim to find data-backed values for the key features responsible for hypoglycaemia, through statistical tests and machine learning algorithms, in order to create a risk score. This risk score can then be applied in hospital to determine the best course of action based on the patient's reason for being admitted.

### 1.4 Report Structure

Section 2 contains a comprehensive, detailed review of similar research carried out by other universities, teaching hospitals and medical facilities including references to relevant medical literature. I have compared and contrasted datasets used, approaches taken and results obtained.

Section 3 delves deeper into the dataset provided by GSTT, elaborating on the raw features provided and those that were derived from them for analysis.

Section 4 (Methodology & Implementation) outlines the statistical and mathematical theory behind the concepts used for analysis, ranging from machine learning algorithms to hypothesis testing methods.

Sections 5 (Main Results) onwards discuss the main research executed within the project and deliberates on the results achieved

Section 6 (Ethical Professional Legal Social issues)

Section 7 (Conclusion and Applicability)

### 1.4.1 Dissertation Length

This dissertation comprises a total of wordcount XXXX words excluding references and appendices.

### 2 Literature Survey & Review

Various kinds of different prediction models have already been devised and developed for predicting hypoglycemia. Yi Wu and others have systematically compared, and evaluated the applicability of models in clinical practice in a paper in Biological Research for Nursing[1] where it was found that the major predictors were age, HbA1c, history of hypoglycemia, and insulin use. Lin Yang, Zhiguang Zhou have carried out similar research in the Frontiers in Public Health journal[2] uncovering risk factors that could possibly lead to hypoglycemic events, after employing various data driven models based on ML techniques such as neural networks, autoregressive / ensemble learning and such.

In silico proof of concept studies like the one from Zecchin[3] have also been researched to investigate how continuous glucose monitoring short-term glucose prediction algorithms could be exploited to recognise the run up to hypoglycemic episodes, allowing the patient to take appropriate countermeasures to mitigate events. They found that there was a significant reduction in both the time spent in a hypoglycemic event as well as the number of hypoglycemic events.

As this is a Knowledge Exchange Project (KEP) with NHS England I have been provided a real world dataset from GSTT. Medical data is difficult to obtain, and it rarely fits a research objective without needing much modification.

### 3 Dataset

Our industry advisor from GSTT has graciously provided a year's worth of data in multiple .xlsx files, which have been combined into one for the purposes of analysis and research for this project. The **raw fields provided** within the data were:

- UniqueID: Unique identifier for the patient and test, which is just a number. Meant to identify same patients (not personally) when considered together with Order Time, Order Date and Age, as same patients can have multiple blood glucose tests during their stay.
- Order Date: The date when the glucose measurement was ordered or taken
- Order Time: The timestamp at which the glucose measurement was ordered or taken
- Inpatient Admission Date: The date at which the patient was admitted into the medical facility
- Discharge Date: The date the patient was discharged from the medical facility
- Length of Stay: The amount of time the patient has spent in the medical facility in days and hours (for eg. "5d 6h")
- Ward: The ward that the glucose measurement was taken in, usually matches the ward that the patient was admitted to
- Last Lab Test Results: The result of the glucose measurement in mmol/L. Most values in this column are of the format "Manual blood glucose: 8.70 mmol/L" or "POCT Glucose Blood Manually: 2.7 mmol/L".
- Age: Age of the patient at the time of measuring blood glucose in years
- Ethnicity: Specific ethnicity of the patient, values ranging from "South American Columbian" to "Black or Black British Nigerian" to "Other" or even missing.
- Gender Identity: Gender of the patient.
- **HbA1c:** Numerical value of HbA1c in mmol/mol.
- HbA1c Date: Date the HbA1c test was done for that patient
- eGFR: Estimated Glomerular Filtration rate, which is a measurement of how well the kidneys are functioning. This is a percentage from 0 to 90, with anything 91 and over displayed by the NHS electronic health record system (Epic) as ">91" because an eGFR of 91 percent and above indicates healthy renal function.
- eGFR Date: The date the eGFR test was conducted.

The variables derived from these features were:

- Age\_Range: Categorical variable to store the age category of the patient based on their age to aid in visualisation. Possible values for this column are: "Young (1 to 25)", "Adult / Middle Aged (26-50)", "Older Adult / Old (51-75)" and "Elderly (76-100)"
- Has\_Hypoglycemia: Binary variable to store whether the patient has hypoglycemia. A glucose measurement of 4mmol/L and below means the patient is hypoglycemic and has 1 in this column, 0 otherwise.
- Glycemia\_Type: Categorical variable to store the type of glycemia based on the patient's glucose measurement. For the purposes of this project, the classes we have been instructed to use are (all units in mmol/L):
  - 1. "Severe Hypoglycemia" for blood glucose values 2.2 and below
  - $2.\,$  "Hypoglycemia"- for blood glucose values from 2.3 to 4 both inclusive
  - 3. "Target Range"- for blood glucose values from 4.1 to 11 both inclusive
  - 4. "Hyperglycemia" for blood glucose values above 11
- eGFR\_Category: Categorical variable that shows how serious the loss of kidney function is, based on the eGFR percentage. The possible values for this column are:
  - 1. "eGFR less than 20 Kidney Failure" for eGFR less than or equal to 20%
  - 2. "eGFR between 20 & 40 Critical Loss of Kidney Function"- for eGFR above 20% but less than or equal to 40%
  - 3. "eGFR between 40 & 60 Significant Loss of Kidney Function"- for eGFR above 40% but less than or equal to 60%
  - 4. "eGFR between 60 & 80 Moderate Loss of Kidney Function"- for eGFR above 60% but less than or equal to 80%
  - 5. "eGFR between 80 & 90 Minor Loss of Kidney Function"- for eGFR above 80% but less than or equal to 90%
  - 6. "eGFR above 90 Normal kidney function"- for eGFR above 90% (data has been processed to only include "91" for this class as healthy eGFR is 91% and above).
- Wider\_Ethnic\_Group: Categorical variable to store the overarching ethnic group based on the one specified in the ethnicity column, as that had a total of 57 unique values. Possible values are: "Unknown or Not Stated", "White", "Mixed", "Asian or Asian British", "Black or Black British" and "Other Ethnic Groups".

Note that columns obtained after cleaning the original data to extract a numerical value (such as blood glucose) have been omitted for brevity.

Please see Appendix A subsection A.1 for screenshots of the dataset(s).

### The content of "Main results" is in "\contents\introduction.tex"

The chapter reports the contributions of your work. For example, it could contain the following sub-sections to summarise the contribution of the project such as Theoretical Development, Analysis and Design, Implementation and Experimental Work, Results, Observation and Discussion.

### 4 Objectives, Specification and Design

It recalls the objectives in a more detailed way to justify the development of a set of requirements and specifications, and identify a coherent set of issues to be addressed. It explains in detail the design and how the design can achieve the project aim (solve the problem).

### 5 Methodology and Implementation

It presents and justifies the methodology used to deal with the problem and describes in detail the implementation procedures. The background theory presented in the previous chapter can be recalled to support the proposed implementation. The originality, novelty and contribution are to be demonstrated with the discussion of the strengths and limitations.

### 6 Results, Analysis and Evaluation

It summarises the results obtained from the proposed design and methodology. The way to obtain the results should be described in detail. Analysis and evaluation have to be performed. Comparisons should be made. It should justifies if the project aims, objectives, requirements and specifications have been achieved.

### 7 Legal, Social, Ethical and Professional Issues

A chapter gives a reasoned discussion about legal, social ethical and professional issues within the context of your project problem. You should also demonstrate that you are aware of the Code of Conduct & Code of Good Practice issued by the British Computer

Society

(BSC)

(https://www.bcs.org/membership/become-a-member/bcs-code-of-conduct/) for computer science project and Rule of Conduct issued by The Institution of Engineering and Technology (IET)

(https://www.theiet.org/about/governance/rules-of-conduct/) for engineering project. You should have applied their principles, where appropriate, as you carried out your project. You could consider aspects like: the effects of your project on the public well-being, security, software trustworthiness and risks, Intellectual Property and related issues, etc.

### 8 Others

This section is for demonstration of equations, figures, tables, which is not required for the report.

#### 8.1 Maths

$$\frac{\mathrm{d}S_t}{S_t} = r\mathrm{d}t + \sigma\mathrm{d}W_t, \qquad S_0 > 0, \tag{8.1}$$

The equation  $\sigma = ma$  follows easily [?].

### 8.2 Glossary and acronyms

Latexlinuxs and other Unix operating systems are better then Windows because they support lymformula out of the box [?].

A ref is missing here

### 8.3 Figures

Here is an example [?] of how to insert a picture:

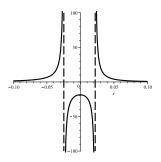


Figure 1: This is the caption for the figure.

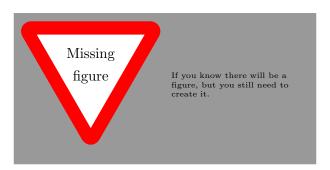


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8.4 Table 10

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or two side-by-side pictures:



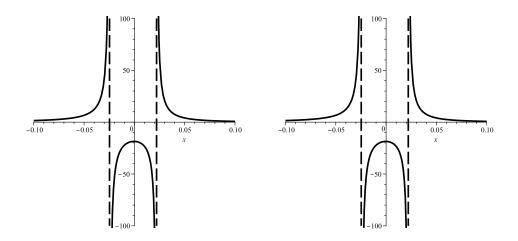


Figure 3: Another caption

#### 8.4 Table

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| [7 | This needs<br>urther<br>explanation |
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| f  | urther                              |
| 6  | explanation                         |

| Something | Someother | Thing                 |
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| Seems     | to be     | $\operatorname{good}$ |

Table 1: Random data for a table.

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### 9 More Others

### 9.1 What is calibration?

Here is an example of a matrix[?] in  $A \in \mathcal{M}_n(\mathbb{R})$ :

$$A = \begin{pmatrix} a_{11} & a_{12} & \dots & a_{1n} \\ a_{21} & \ddots & \ddots & \vdots \\ \vdots & \ddots & \ddots & \vdots \\ a_{n1} & \dots & \dots & a_{1n}. \end{pmatrix}$$

### 9.2 Numerical methods for calibration

...

The content of "Conclusion" is in "\contents\conclusion.tex"

### 10 Conclusion

It is a chapter to sum up the main points and findings of the work; how you achieve the project aims and address the research questions; the contributions and results you have achieved. Future plan and development can be mentioned in this section as well. It is normally in one or two pages.

References 13

### References

[1] Diabetes UK, "Cost of devastating complications highlights urgent need to transform diabetes care in the UK." URL. Accessed: 2025-07-07.

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- [5] NHS Digital, "National diabetes audit 2021-22, report 1: Care processes and treatment targets, detailed analysis report." National Diabetes Audit 2021-22. Accessed: 2025-07-07.

References 14

# A Appendix

## A.1 Dataset

| Marche   Order Chee, Order C              | A            |            | 0            |           |                   |                           |                        |                                    | J   | 7                        | Σ          | z             | 0         | Р                      |
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| 20. E. O. CARDONIO LITELEZ DE SERESSEZ DE CARDONIO CARDONIO VARIAD Munual blood glucose 1.000 mmol. 2 glade ce glade famille. Unspecified Female Fe                                   | 266 265      | 05,06,2025 | 10:58:03     | 248956356 | 05,06,2025        | 06,06,2025 1d 9h          | GH RICHARD BRIGHT WARE | Manual blood glucose: 6.20 mmol/L  | 64 Not stated/Undefined                   | Male                     | 82         | 19,12,2024    | 23        | 27,06,2025             |
|   | 262          | 05,06,2025 | 11:02:08     | 248958252 | 05,06,2025        | 06,06,2025 1d 9h          | STH GYNAECOLOGY WARD   | Manual blood glucose: 10.80 mmol/L | 52 Black or Black British - Unspecified   | Female                   |            |               | 77        | 06,06,2025             |
| 200 (20,00,202)         1131-1315-1315         38886373-10         6,00,00,202         13,00,00,202         13,00,00,202         13,00,00,202         13,00,00,202         13,00,00,202         13,00,00,202         13,00,00,202         13,00,00,202         13,00,00,202         13,00,00,202         13,00,00,202         13,00,00,202         13,00,00,202         13,00,00,202         13,00,00,00,202         13,00,00,00,202         13,00,00,00,202         13,00,00,00,202         13,00,00,00,202         13,00,00,00,202         13,00,00,00,202         13,00,00,00,202         13,00,00,00,202         13,00,00,00,202         13,00,00,00,00,00         13,00,00,00,00   | 267          | 05,06,2025 | 11:02:22     | 248958363 | 05,06,2025        | 06,06,2025 1d 9h          | STH GYNAECOLOGY WARD   | Manual blood glucose: 12.00 mmol/L | 52 Black or Black British - Unspecified   | Female                   |            |               | 77        | 06,06,2025             |
| 200 00,00,2020         11,518-18         3,898,988-88         3,40,2020         3,74         35 TH HULLMA OLIU, WALDM Manual bloods gloones 3.20 mmol/l. 8 white-a bridge brown of the white background Choose north ordering 6.00         6,00,2020         11,518-202         3,00,2020         3,00,   |              | 05,06,2025 | 11:21:12     | 248968251 | 05,06,2025        | 05,06,2025 3h             | STH ADMISSIONS WARD    | Manual blood glucose: 10.10 mmol/L | 56  |                          |            |               | 78        | 05,06,2025             |
| 4 0.06,2020         12.64.23         26.06,2020         12.64.23         26.06,2020         12.64.24         25.06,2020         12.64.24         25.06,2020         12.64.24         25.06,2020         12.64.24         25.06,2020         12.64.24         25.06,2020         12.64.24         25.06,2020         12.64.24         25.06,2020         12.64.24         25.06,2020         12.65.24         25.06,2020         12.64.24         25.06,2020         12.64.24         25.06,2020         12.64.24         25.06,2020         12.64.24         25.06,2020         12.64.24         25.06,2020         12.64.24         25.06,2020         12.65.24         25.06,2020         12.65.24         25.06,2020         12.65.24         25.06,2020         12.65.25         26.06,2020         12.65.24         25.06,2020         12.65.24         25.06,2020         12.65.24         25.06,2020         12.65.24         25.06,2020         12.06,2020  |              | 05,06,2025 | 11:58:35     | 248986846 | 24,01,2025        | 157d 18h                  | STH WILLIAM GULL WARD  | Manual blood glucose: 5.20 mmol/L  | 59 Black or Black British - African       | Female                   | 43         | 20,01,2024    | 28        | 01,07,2025 121 kg      |
| 20         50         20<  | 271 3        | 05,06,2025 | 11:59:38     | 248987330 | 25,05,2025        | 18,06,2025 24d 2h         | STH WILLIAM GULL WARD  | Manual blood glucose: 10.40 mmol/L | 88 White - Any other White background     | d Choose not to disclose |            | 30,04,2024    | 59        | 18,06,2025             |
| 20. 06.06.2029         21.254.2024         20.00.2024         20   |              | 05,06,2025 | 12:06:47     | 248990954 | 05,06,2025        | 06,06,2025 1d 9h          | GH RICHARD BRIGHT WARE | Manual blood glucose: 5.70 mmol/L  | 64 Not stated/Undefined                   | Male                     | 82         | 19,12,2024    | 23        | 27,06,2025             |
| 213         60.06, 2025         21.45.42         28901141         11.05, 2025         46.46 pill         57.1 (10.05, 2025)         21.45.22         28901141         11.05, 2025         20.05, 2025         21.05, 2025         20.05,  |              | 05,06,2025 | 12:21:30     | 248998333 | 16,05,2025        | 27,06,2025 42d 1h         | STH SARAH SWIFT WARD   | Manual blood glucose: 11.90 mmol/L | 76 White - British                        |                          |            |               | 19        | 27,06,2025             |
| 11 0 G.06,2023 134312 3954315 11.0.5.0.5.0.2. 3 361 361 361 STH VILLARIA MARD Manual blood glucose 4.58 mmol/L 21 VIVA Whete - English Male a Seeker 11 O G.06,2025 14.0.5.0.2. 3 361 361 361 STH VILLARIA MARD Manual blood glucose 4.58 mmol/L 21 VIVA Whete - English Male 200,000 200 200 200 200 200 200 200 200   |              | 05,06,2025 | 12:54:34     | 249011417 | 17,05,2025        | 42d 9h                    | STH HILLYERS WARD      | Manual blood glucose: 7.40 mmol/L  | 74 Black or Black British - Caribbean     |                          | 22         | 22,04,2024    | 20        | 30,06,2025 95 kg       |
| 275 0.00,00,002 3. 5412646 24905273 1 00,00,00,202 3.6.3 9. 07,00,40,202 3.6.3 9. 07,00,40,202 3.6.3 9. 07,00,40,202 3.6.3 9. 07,00,40,202 3.6.3 9. 07,00,40,202 3.0 9. 07,00,4002 3.0 9. 07,00,            |              | 05,06,2025 | 13:43:17     | 249031415 | 31,05,2025        | 30d 18h                   | STH WILLIAM GULL WARD  | POCT Glucose Blood Manually En: 7. | 52 White - English                        |                          |            |               | >90       | 27,06,2025 55 kg       |
| 270         Co.05, 2025         15,577.23         20,905,2025         Co.05, 2025         Co.   |              | 05,06,2025 | 14:16:46     |           | 04,06,2025        | 07,06,2025 3d 3h          | GH FLORENCE WARD       | Manual blood glucose: 4.80 mmol/L  | 74 White - English                        | Male                     |            |               | 32        | 24,06,2025             |
| 270         Co.S. 6, 2023         1, 20, 20, 2023         2, 20, 4, 2023         3, 20, 4, 2023 <td></td> <td>05,06,2025</td> <td>15:07:28</td> <td></td> <td>04,06,2025</td> <td>20,06,2025 16d</td> <td>STH GI PAGE WARD</td> <td>Manual blood glucose: 7.20 mmol/L</td> <td>81 Not stated/Undefined</td> <td></td> <td>61</td> <td>13,11,2023</td> <td>82</td> <td>20,06,2025</td>  |              | 05,06,2025 | 15:07:28     |           | 04,06,2025        | 20,06,2025 16d            | STH GI PAGE WARD       | Manual blood glucose: 7.20 mmol/L  | 81 Not stated/Undefined                   |                          | 61         | 13,11,2023    | 82        | 20,06,2025             |
| 28 6.06,2025 1542-22 2498982255 60.05,2025 10.0 STHAADMISTON WARPO Natural blood gluccae; 5.0 mmol/L 5.0 Black or Black Britts <sup>1</sup> . Affrican Male 6.0 5.0 STA CARLO STA |              | 05,06,2025 |              |           | 01,06,2025        | 06,06,2025 5d 16h         | STH ALEXANDRA WARD     | Manual blood glucose: 6.50 mmol/L  | 78 Black or Black British - Caribbean     | Female                   | 39         | 24,04,2025    | 5         | 17,06,2025             |
| 279         55,6,6,2025         25,6,6,2025         6,6,6,2025         6,0,6,2025         6,0,6,2025         6,0,0,2025         6,0,0,2025         6,0,0,2025         6,0,0,2025         6,0,0,2025         6,0,0,2025         6,0,0,2025         6,0,0,2025         6,0,0,2025         6,0,0,2025         6,0,0,2025         6,0,0,2025         6,0,0,2025         6,0,0,2025         1,0,0,0,0,2025         1,0,0,0,0,2025         1,0,0,0,0,2025         1,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0,0   |              | 05,06,2025 | 15:42:24     | 249082295 | 06,06,2025        | 06,06,2025 16h            | STH ADMISSIONS WARD    | Manual blood glucose: 9.60 mmol/L  | 68 Black or Black British - African       | Male                     | 47         | 03,05,2024    | 28        | 06,06,2025             |
| 280 05.05 221 51.05.2 259912565 0 05.06.2023 1d.10h 0 GH.ASTON KEYWARD Manual blood glucose; 6.30 mm/l, 1.2 Black or Black Girtish -Gribbean Male Grant College Colleg            |              | 05,06,2025 | 15:56:30     | 249087656 | 01,06,2025        | 09,06,2025 8d 17h         | STH ALBERT WARD        | Manual blood glucose: 5.70 mmol/L  | 34 Black or Black British - African       | Male                     |            |               | >90       | 25,06,2025             |
| 281 65.06,2023 1635942 606,052025 Id109 GHOVARCECLOCKOVARD Manual blood glucose: 5.30 mmol/l. 72 Black or Black Britsh- Unspecified Female 67 1704,024 9 60 60 60 60 60 60 60 60 60 60 60 60 60   |              | 05,06,2025 | 16:07:02     | 249091566 | 05,06,2025        | 06,06,2025 1d 10h         | GH ASTON KEY WARD      | Manual blood glucose: 6.10 mmol/L  | 72 Black or Black British - Caribbean     | Male                     | 43         | 17,04,2024    | 09        | 06,06,2025             |
| 267         CO. Go. 2022         173-636.9         450-60.202         CO. Go. 2022         GO. Go. 2022         <   | 281          | 05,06,2025 | 16:59:47     | 249109429 | 05,06,2025        | 06,06,2025 1d 9h          | STH GYNAECOLOGY WARD   |                                    | 52 Black or Black British - Unspecified   | Female                   |            |               | 77        | 06,06,2025             |
| 281         65,06,2025         11,55,500         24912117         65,06,2025         14,04,2025         70,95         71,04,2024         90           281         65,06,2025         18,05,42         491,204,2025         20,04,2025         40.9         71,04,2024         70         71,04,2024         70         71,04,2025         70         70         70,05,2025         40.14         71,04,2024         70         <  |              | 05,06,2025 | 17:36:36     |           | 05,06,2025        | 06,06,2025 1d 10h         | GH ASTON KEY WARD      | Manual blood glucose: 6.30 mmol/L  | 72 Black or Black British - Caribbean     | Male                     | 43         | 17,04,2024    | 90        | 06,06,2025             |
| 284         65,002         31,004,2025         704 9h         71H ARK WARPD         Manuab blood glucoses: 5.10 mmol/L         68 White - British         Art 20,40,2025         40,00,2025  | 281          | 05,06,2025 | 17:55:00     |           | 05,06,2025        | 06,06,2025 1d 1h          | GH SARAH WARD          | Manual blood glucose: 6.50 mmol/L  | 69 White - English                        |                          |            |               | >30       | 05,06,2025             |
| 28 G. 66, 2025 19-27-24 24912-2405 G. 03-06, 2025 4 C. 14 Maruab look glucose: 1.0.8 mmol/L 6 Natural blook glucose: 1.0.8 mmol/L 6 Natural 8 Natural blook glucose: 1.0.8 mmol/L 6 Natural 8 Natural             | 284          | 05,06,2025 | 18:03:54     |           | 22,04,2025        | 46 poz                    | STH MARK WARD          | Manual blood glucose: 5.10 mmol/L  | 68 White - British                        |                          | 47         | 12,04,2024    | >30       | 30,06,2025 75 kg       |
| 118 05.06,2025 1925-37 249134793 0.06,02025 10.06,2025             | 282          | 05,06,2025 | 19:02:34     | 249132405 | 03,06,2025        | 07,06,2025 4d 13h         | GH ASTON KEY WARD      | Manual blood glucose: 10.80 mmol/L | 50 Black or Black British - Any other Bla | ck Female                | 109        | 10,06,2025    | >30       | 10,06,2025             |
| 10 50.6,2025 19:278.42 24913473 0,50,6,2025 12.06,2025 6 021h STH WILLIAM GULL WARD Marual blood glucose: 1.10 mmol/L S S S S S S S S S S S S S S S S S S S   |              | 05,06,2025 | 19:25:07     | 249134589 | 17,05,2025        | 45d 9h                    | STH HILLYERS WARD      | Manual blood glucose: 6.00 mmol/L  | 74 Black or Black British - Caribbean     |                          | 54         | 22,04,2024    | 50        | 30,06,2025 95 kg       |
| 28         65,602.02         19.27-27.2         49134791         30,04,2025         61d 17h         STH WILLIAM GULL WARD         Manual blood glucose: 3.30 mmol/L         51 White- Any other Ewhite background         Male         72         72         72         72         72         72         73  |              | 05,06,2025 | 19:26:43     | 249134739 | 05,06,2025        | 12,06,2025 6d 21h         | STH WILLIAM GULL WARD  | Manual blood glucose: 11.10 mmol/L | 65 White - English                        | Male                     |            |               | 70        | 30,06,2025             |
| 12 G5,06,2025 19-56-11 7551386 G 05,06,2025 14h STH ADMISSIONIS WARD Manual blood glucoses: 9.20 mmol/L 31 Black or Black British - Caribbean Age 140,4,2025 140,4,2025 17417h STH SOMERSET WARD Manual blood glucoses: 9.20 mmol/L 35 Any other Ethnic Group Male 8 140,4,202 17417h STH SOMERSET WARD Manual blood glucoses: 9.20 mmol/L 35 Any other Ethnic Group Male 8 140,4,202 17417h STH SOMERSET WARD Manual blood glucoses: 9.20 mmol/L 35 Black or Black British - Caribbean Female 8 06,6,202 10,000 10            |              | 05,06,2025 | 19:27:27     | 249134791 | 30,04,2025        | 61d 17h                   | STH WILLIAM GULL WARD  | Manual blood glucose: 13.00 mmol/L | 59 White - Any other White background     | d Male                   |            |               | 72        | 26,06,2025 62.3 kg     |
| 290         0.5.06,2025         20.43.210         29140609         14.04,2025         77d 17h         STH SOMRESET WARD         Manual blood glucose; 3.00 mmol/L         35 Any Other Ethnic Group         Male         Male         PRISON MARSET WARD         Manual blood glucose; 3.00 mmol/L         35 Any Other Ethnic Group         Male         90.00,2023         20   | 112          | 05,06,2025 | 19:56:11     | 75513886  | 05,06,2025        | 06,06,2025 14h            | STH ADMISSIONS WARD    | Manual blood glucose: 9.20 mmol/L  | 41 Black or Black British - Caribbean     |                          |            |               | 63        | 06,06,2025             |
| 148 05.06,2025 2043-348 24914042 0 14,04,2025 14 134  | 290          | 05,06,2025 | 20:42:10     | 249140609 | 14,04,2025        | 77d 17h                   | STH SOMERSET WARD      | Manual blood glucose: 3.40 mmol/L  | 35 Any Other Ethnic Group                 | Male                     |            |               | 81        | 29,06,2025 77 kg       |
| 148 G.5,6,2025 210-74-21 249140759 G.6,6,2025 16h 77 PA DANISSIONS WARD POT Glucose Blood Marual blood glucose: 6.60 mmol/L 87 Black or Black British - Grinbean Female 40 G.6,2023 50 G.6,2025 16h 77 PA DANISSIONS WARD POT Glucose Blood Manually E:11 68 Black or Black British - African Male 47 G.9,5,2024 58 S S S G.6,5,2025 16h G.6,2025 16h G.6,2025 16h G.6,2025 16h G.6,2025 16h G.6,2025 12h G.6,2025 12               | 148          | 05,06,2025 | 20:42:48     |           | 14,04,2025        | 77d 17h                   | STH SOMERSET WARD      | Manual blood glucose: 4.30 mmol/L  | 35 Any Other Ethnic Group                 | Male                     |            |               | 81        | 29,06,2025 77 kg       |
| 239         65,02025         21:07-42         294942353         06,06,2025 (0.002)         50,000,2025 (0.002)         50,000,2025 (0.002)         50,000,2025 (0.002)         60,000,2025 (0.002)         60,000,2025 (0.000)         70,000,2025 (0.000)  | 148          | 05,06,2025 | 20:44:12     |           | 06,06,2025        | 07,06,2025 1d 13h         | STH SOMERSET WARD      | Manual blood glucose: 6.60 mmol/L  | 53 Black or Black British - Caribbean     | Female                   | 40         | 08,12,2023    | >30       | 05,06,2025             |
| 279         Go, Go, 2025         21:07:45         49:142357         Go, Go, 2025         140         AG  | 293          | 05,06,2025 | 21:07:42     | 249142353 | 06,06,2025        | 06,06,2025 16h            | STH ADMISSIONS WARD    |                                    | 68 Black or Black British - African       | Male                     | 47         | 03,05,2024    | 58        | 06,06,2025             |
| 279 GS,06,2025 21:16:33 249143099 05.06,2025 10.1 HALEAMBA WARD Manual blood glucose: 12.40 mmol/l. 80 White-English 590 970 50.06,2025 21:43:10 249144918 20.06,2025 21:43:10 249144918 20.06,2025 21:43:11 2491414918 20.06,2025 21:43:12 2491414918 21.06,2025 21:43:12 2491414918 21.06,2025 21:43:12 2491414918 21.06,2025 21:43:12 2491414918 21.06,2025 21:43:12 2491414918 21.06,2025 21:43:12 249141918 21.06,2025 21:43:12 249141918 21.06,2025 21:43:12 249141918 21.06,2025 21:43:12 249141918 21.06,2025 21:43:12 249141918 21.06,2025 21:43:12 249141918 21.06,2025 21:43:12 24914918 21.06,2025 21:43:12 24914918 21.06,2025 21:43:12 24914918181 21.06,2025 21:43:12 249149181 21.06,2025 21:43:12 249149181 21.06,2025 21:43:12 24914            |              | 05,06,2025 | 21:07:45     | 249142357 | 06,06,2025        | 06,06,2025 16h            | STH ADMISSIONS WARD    | POCT Glucose Blood Manually E: 11. | 68 Black or Black British - African       | Male                     | 47         | 03,05,2024    | 58        | 06,06,2025             |
| 284 65,66,2025 21:43:01 249144918 21,05,2025 40.29h STH ALEXANDRA WARD Manual blood glucose: 6.20 mmol/L 88 White Any other White background Choose not to disclose 5.20 mmol/L 88 White Any other White background Choose not to disclose 5.30 mmol/L 88 White Any other White background Choose not to disclose 5.30 mmol/L 87 65,62025 22:44:61 249147818 24912491 14,42,2025 10,62,2025 71317 STH STH WARR WARD Manual blood glucose: 5.30 mmol/L 72 shard or Asian British - Arizon Caribbean Male 80,60,52025 10,62,2025 71 14,62,2025 71 18,05,            |              | 05,06,2025 | 21:16:33     | 249143099 | 05,06,2025        | 06,06,2025 1d 1h          | GH SARAH WARD          | Manual blood glucose: 12.40 mmol/L | 69 White - English                        |                          |            |               | >30       | 05,06,2025             |
| 297 65,66,2025 22:01:57 249146383 25,65,2025 24 2h STH WILLIAM GULL WARD Manual blood glucose: 5.100 mmol/L S Black or Black British - African Female 23 30,04,2024 59 30,04,2024 59 30,04,2025 24 2h STH WILLIAM GULL WARD Manual blood glucose: 5.00 mmol/L S Black or Black British - African Female 24 30,04,2024 59 30 05,06,2025 24:445 24912901 14,04,2025 71 14,04,202            | 284          | 05,06,2025 | 21:43:01     | 249144918 | 21,05,2025        | 40d 19h                   | STH ALEXANDRA WARD     | Manual blood glucose: 6.20 mmol/L  | 82 Not stated/Undefined                   |                          |            |               | 53        | 01,07,2025 67.2 kg     |
| 4 05.06,2025 22:13:12 249147160 24.01,2025 44.94 STH WILLIAM GULL WARD Manual blood glucose: 6.10 mmol/L S Black or Black British - African Female 43 20.01,2024 58 13.05,2024 49 STH MARK WARD Manual blood glucose: 5.00 mmol/L 72 Asia 24914521 14.04,2025 74 18h STH SOMESET WARD Manual blood glucose: 5.00 mmol/L 72 Asia 24914521 14.04,2025 74 18h STH SOMESET WARD Manual blood glucose: 5.00 mmol/L 72 Asia 24914521 14.04,2025 74 18h STH ALEXANDRA WARD Manual blood glucose: 5.00 mmol/L 9 Black or Black or Black or Black British - Caribbean Female 75 And 18h STA 18h            |              | 05,06,2025 | 22:01:57     | 249146383 | 25,05,2025        | 18,06,2025 24d 2h         | STH WILLIAM GULL WARD  | Manual blood glucose: 11.00 mmol/L | 88 White - Any other White background     | d Choose not to disclose |            | 30,04,2024    | 59        | 18,06,2025             |
| 3 05,06,2025 2246/05 24914981 06,06,2025 44914981 10,06,2025 44914981 10,06,2025 44914981 10,06,2025 44914981 10,06,2025 4491491 10,04,2025 4491491491 10,04,2025 449            | 299 4        | 05,06,2025 | 22:13:12     |           | 24,01,2025        | 157d 18h                  | STH WILLIAM GULL WARD  | Manual blood glucose: 6.10 mmol/L  | 59 Black or Black British - African       | Female                   | 43         | 20,01,2024    | 58        | 01,07,2025 121 kg      |
| 300 05,06,2025 23:44:45 249152341 14,04,2025 77d 17h STH SOMERSET WARD Manual blood glucose: 5.80 mmol/L 99 Black or Black British - Caribbean Female 26 05,06,2025 16:48:01 77,06,2025 17d 18h STH ALEXANDRA WARD Manual blood glucose: 6.80 mmol/L 99 Black or Black British - Caribbean Female 26 26 26 2025 27d 18h STH ALEXANDRA WARD Manual blood glucose: 6.80 mmol/L 99 Black or Black British - Caribbean Female 26 26 26 2025 27d 18h STH ALEXANDRA WARD Manual blood glucose: 6.80 mmol/L 99 Black or Black British - Caribbean Female 26 26 26 2025 27d 18h STH ALEXANDRA WARD MANUAL BLOOD GLUCOSE: 6.80 mmol/L 99 Black or Black British - Caribbean Female 26 26 26 27d  | 8            | 05,06,2025 | 22:46:05     |           | 06,06,2025        | 10,06,2025 4d 9h          | STH MARK WARD          | Manual blood glucose: 9.20 mmol/L  | 72 Asian or Asian British - Arab          | Male                     | 64         | 13,05,2024    | 59        | 26,06,2025             |
| 16:48:01 29383951 07;06,2025 74.18h STHALEXANDRA WARD Manual blood glucose: 6.80 mmol/L 99 Black or Black British - Caribbean Female 26   |              | 05,06,2025 | 23:44:45     | 249152341 | 14,04,2025        | 77d 17h                   | STH SOMERSET WARD      | Manual blood glucose: 5.80 mmol/L  | 35 Any Other Ethnic Group                 | Male                     |            |               | 81        | 29,06,2025 77 kg       |
|   | 302 148      | 06,06,2025 | 16:48:01     | 249383961 | 07,06,2025        | 14,06,2025 7d 18h         | STH ALEXANDRA WARD     | Manual blood glucose: 6.80 mmol/L  | 99 Black or Black British - Caribbean     | Female                   |            |               | 26        | 16,06,2025             |

Figure 4: Raw dataset

A.1 Dataset

| J ×  | L                      | Σ             | Z                                  | ر<br>م                | N 0   | ۸<br>۸                  | Z AA  |
|--|------------------------|---------------|------------------------------------|-----------------------|---|-------------------------|---|
| Age Ethnicity  | Gender Identity        | Last HbA1c La | Last HbA1c Last HBA1C Dt Last eGFR |                       | EGFR Date Admit Weight Glucose Value Length of Stay (Ti Age_Range | Has_Hypo{ Glycemia_Type | eGFR_Category Wider_Ethnic_Group  |
| 99   |                        |               |                                    | 78 05,06,2025         | 10.1 0 days 03:00:00 Older Adult / Old (51-75)                    | 0 Target Range          | eGFR between 60 & 80 - Moderate Loss of Kidney F Unknown or Not Stated    |
| 59 Black or Black British - African                            | Female                 | 43            | 20,01,2024                         | 58 01,07,2025 121 kg  | 5.2 157 days 18:00:00 Older Adult / Old (51-75)                   | 0 Target Range          | eGFR between 40 & 60 - Significant Loss of Kidney Black or Black British  |
| 88 White - Any other White background Choose not to disclose   | Choose not to disclose | 53            | 30,04,2024                         | 59 18,06,2025         | 10.4 24 days 02:00:00 Elderly (76-100)                            | 0 Target Range          | eGFR between 40 & 60 - Significant Loss of Kidney White                   |
| 64 Not stated/Undefined  | Male                   | 82            | 19,12,2024                         | 23 27,06,2025         | 5.7 1 days 09:00:00 Older Adult / Old (51-75)                     | 0 Target Range          | eGFR between 20 & 40 - Critical Loss of Kidney Fun Unknown or Not Stated  |
| 76 White - British   |                        |               |                                    | 61 27,06,2025         | 11.9 42 days 01:00:00 Elderly (76-100)                            | 0 Hyperglycemia         | eGFR between 60 & 80 - Moderate Loss of Kidney F White                    |
| 74 Black or Black British - Caribbean                          |                        | 54            | 22,04,2024                         | 50 30,06,2025 95 kg   | 7.4 45 days 09:00:00 Older Adult / Old (51-75)                    | 0 Target Range          | eGFR between 40 & 60 - Significant Loss of Kidney Black or Black British  |
| 52 White - English   |                        |               | 06<                                | 27,06,2025 55 kg      | 7.5 30 days 18:00:00 Older Adult / Old (51-75)                    | 0 Target Range          | eGFR above 90 - Normal kidney function White                              |
| 74 White - English   | Male                   |               |                                    | 32 24,06,2025         | 4.8 3 days 03:00:00 Older Adult / Old (51-75)                     | 0 Target Range          | eGFR between 20 & 40 - Critical Loss of Kidney Fun White                  |
| 81 Not stated/Undefined  |                        | 61            | 13,11,2023                         | 82 20,06,2025         | 7.2 16 days 00:00:00 Elderly (76-100)                             | 0 Target Range          | eGFR between 80 & 90 - Minor Loss of Kidney Fund Unknown or Not Stated    |
| 78 Black or Black British - Caribbean                          | Female                 | 39            | 24,04,2025                         | 5 17,06,2025          | 6.5 5 days 16:00:00 Elderly (76-100)                              | 0 Target Range          | eGFR less than 20 - Kidney Failure Black or Black British                 |
| 68 Black or Black British - African                            | Male                   | 47            | 03,05,2024                         | 58 06,06,2025         | 9.6 0 days 16:00:00 Older Adult / Old (51-75)                     | 0 Target Range          | eGFR between 40 & 60 - Significant Loss of Kidney Black or Black British  |
| 34 Black or Black British - African                            | Male                   |               | 06<                                | 25,06,2025            | 5.7 8 days 17:00:00 Adult / Middle Aged (26-50)                   | 0 Target Range          | eGFR above 90 - Normal kidney function Black or Black British             |
| 72 Black or Black British - Caribbean                          | Male                   | 43            | 17,04,2024                         | 60 06,06,2025         | 6.1 1 days 10:00:00 Older Adult / Old (51-75)                     | 0 Target Range          | eGFR between 40 & 60 - Significant Loss of Kidney Black or Black British  |
| 52 Black or Black British - Unspecified                        | Female                 |               |                                    | 77 06,06,2025         | 7.5 1 days 09:00:00 Older Adult / Old (51-75)                     | 0 Target Range          | eGFR between 60 & 80 - Moderate Loss of Kidney FBlack or Black British    |
| 72 Black or Black British - Caribbean                          | Male                   | 43            | 17,04,2024                         | 60 06,06,2025         | 6.3 1 days 10:00:00 Older Adult / Old (51-75)                     | 0 Target Range          | eGFR between 40 & 60 - Significant Loss of Kidney Black or Black British  |
| 69 White - English   |                        |               | >90                                | 05,06,2025            | 6.5 1 days 01:00:00 Older Adult / Old (51-75)                     | 0 Target Range          | eGFR above 90 - Normal kidney function                                    |
| 68 White - British   |                        | 47            | 12,04,2024 >90                     | 30,06,2025 75 kg      | 5.1 70 days 09:00:00 Older Adult / Old (51-75)                    | 0 Target Range          | eGFR above 90 - Normal kidney function White                              |
| 50 Black or Black British - Any other Black Female             | . Female               | 109           | 10,06,2025 >90                     | 10,06,2025            | 10.8 4 days 13:00:00 Adult / Middle Aged (26-50)                  | 0 Target Range          | eGFR above 90 - Normal kidney function Black or Black British             |
| 74 Black or Black British - Caribbean                          |                        | 54            | 22,04,2024                         | 50 30,06,2025 95 kg   | 6 45 days 09:00:00 Older Adult / Old (51-75)                      | 0 Target Range          | eGFR between 40 & 60 - Significant Loss of Kidney Black or Black British  |
| 65 White - English   | Male                   |               |                                    | 70 30,06,2025         | 11.1 6 days 21:00:00 Older Adult / Old (51-75)                    | 0 Hyperglycemia         | eGFR between 60 & 80 - Moderate Loss of Kidney FWhite                     |
| 59 White - Any other White background Male                     | Male                   |               |                                    | 72 26,06,2025 62.3 kg | 13 61 days 17:00:00 Older Adult / Old (51-75)                     | 0 Hyperglycemia         | eGFR between 60 & 80 - Moderate Loss of Kidney F White                    |
| 41 Black or Black British - Caribbean                          |                        |               |                                    | 63 06,06,2025         | 9.2 0 days 14:00:00 Adult / Middle Aged (26-50)                   | 0 Target Range          | eGFR between 60 & 80 - Moderate Loss of Kidney FBlack or Black British    |
| 35 Any Other Ethnic Group                                      | Male                   |               |                                    | 81 29,06,2025 77 kg   | 3.4 77 days 17:00:00 Adult / Middle Aged (26-50)                  | 1 Hypoglycemia          | eGFR between 80 & 90 - Minor Loss of Kidney Func Other Ethnic Groups      |
| 35 Any Other Ethnic Group                                      | Male                   |               |                                    | 81 29,06,2025 77 kg   | 4.3 77 days 17:00:00 Adult / Middle Aged (26-50)                  | 0 Target Range          | eGFR between 80 & 90 - Minor Loss of Kidney Func Other Ethnic Groups      |
| 53 Black or Black British - Caribbean                          | Female                 | 40            | 08,12,2023 >90                     | 05,06,2025            | 6.6 1 days 13:00:00 Older Adult / Old (51-75)                     | 0 Target Range          | eGFR above 90 - Normal kidney function Black or Black British             |
| 68 Black or Black British - African                            | Male                   | 47            | 03,05,2024                         | 58 06,06,2025         | 0 days 16:00:00 Older Adult / Old (51-75)                         |                         | eGFR between 40 & 60 - Significant Loss of Kidney Black or Black British  |
| 68 Black or Black British - African                            | Male                   | 47            | 03,05,2024                         | 58 06,06,2025         | 11.4 0 days 16:00:00 Older Adult / Old (51-75)                    | 0 Hyperglycemia         | eGFR between 40 & 60 - Significant Loss of Kidney Black or Black British  |
| 69 White - English   |                        |               | >90                                | 05,06,2025            | 12.4 1 days 01:00:00 Older Adult / Old (51-75)                    | 0 Hyperglycemia         | eGFR above 90 - Normal kidney function White                              |
| 82 Not stated/Undefined  |                        |               |                                    | 53 01,07,2025 67.2 kg | 6.2 40 days 19:00:00 Elderly (76-100)                             | 0 Target Range          | eGFR between 40 & 60 - Significant Loss of Kidney Unknown or Not Stated   |
| 88 White - Any other White background   Choose not to disclose | Choose not to disclose | 23            | 30,04,2024                         | 59 18,06,2025         | 11 24 days 02:00:00 Elderly (76-100)                              | 0 Target Range          | eGFR between 40 & 60 - Significant Loss of Kidney White                   |
| 59 Black or Black British - African                            | Female                 | 43            | 20,01,2024                         | 58 01,07,2025 121 kg  | 6.1 157 days 18:00:00 Older Adult / Old (51-75)                   | 0 Target Range          | eGFR between 40 & 60 - Significant Loss of Kidney Black or Black British  |
| 72 Asian or Asian British - Arab                               | Male                   | 64            | 13,05,2024                         | 59 26,06,2025         | 9.2 4 days 09:00:00 Older Adult / Old (51-75)                     | 0 Target Range          | eGFR between 40 & 60 - Significant Loss of Kidney Asian or Asian British  |
| 35 Any Other Ethnic Group                                      | Male                   |               |                                    | 81 29,06,2025 77 kg   | 5.8 77 days 17:00:00 Adult / Middle Aged (26-50)                  | 0 Target Range          | eGFR between 80 & 90 - Minor Loss of Kidney Func Other Ethnic Groups      |
| 99 Black or Black British - Caribbean                          | Female                 |               |                                    | 26 16,06,2025         | 6.8 7 days 18:00:00 Elderly (76-100)                              | 0 Target Range          | eGFR between 20 & 40 - Critical Loss of Kidney Fun Black or Black British |
| 76 White - British   |                        |               |                                    | 61 27,06,2025         | 7.3 42 days 01:00:00 Elderly (76-100)                             | 0 Target Range          | eGFR between 60 & 80 - Moderate Loss of Kidney f White                    |
| 88 White - British   | Female                 | 19            | 22,01,2024                         | 49 10,06,2025         | 4.8 6 days 21:00:00 Elderly (76-100)                              | 0 Target Range          | eGFR between 40 & 60 - Significant Loss of Kidney White                   |
| 71 White Dritich   |                        |               | OB<                                | 2005 30 70            | 6.2 3 days 08:00:00 Older Adult / Old (51-75)                     | O Target Range          | of FB above 90 - Normal Lidney function                                   |

Figure 5: Dataset with cleaned features