CHRONIC KIDNEY DISEASE PATIENT CARE APPLICATION

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B.Sc. (Hons) Degree in Information Technology
Specializing in Data Science

Department of Information Technology

Sri Lanka Institute of Information Technology
Sri Lanka

September 2023

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Dissertation submitted in partial fulfillment of the requirements for the Bachelor of Science (Hons) in Information Technology Specializing in Data Science

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DECLARATION

Declaration of the Candidate

I declare that this is my own work, and this proposal does not incorporate without acknowledgement any material previously submitted for a degree or diploma in any other university or Institute of higher learning and to the best of our knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

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Declaration of the Supervisor

The above candidates are carrying out research for the undergraduate Dissertation under my supervision.

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ABSTRACT

Chronic Kidney Disease (CKD) has emerged as a significant global health concern, demanding innovative solutions to enhance the quality of life for affected individuals. This research endeavors to address this challenge by harnessing the power of machine learning (ML) to predict and implement personalized diet plans for CKD patients. The study draws upon data collected manually from the Kurunegala Teaching Hospital, which serves as the foundation for building and evaluating four distinct ML models: Neural Network, Decision Tree, Logistic Regression, and Random Forest Regression. The research process commences with meticulous data gathering, followed by comprehensive data preprocessing to ensure data quality and consistency. Subsequently, the four ML models are trained using the processed dataset. The performance evaluation reveals promising results, with the Neural Network achieving an accuracy of 83.22%, the Decision Tree reaching an impressive 99.32%, Logistic Regression attaining 88.59%, and the Random Forest Regressor demonstrating an outstanding 99.93% accuracy rate. Upon careful analysis, the Random Forest Regressor emerges as the optimal model, signifying its potential to provide the most accurate predictions for CKD diet plans. The implementation phase of this research culminates in the development of a Python-based model, which leverages the Random Forest Regressor to create personalized diet plans tailored to the unique needs of each CKD patient. These diet plans encompass four distinct categories, ensuring that patients receive the most suitable dietary recommendations for their condition. Furthermore, this research takes a step towards enhancing patient care by introducing a mobile application specifically designed for CKD patients. This app serves as a valuable tool to disseminate diet plans, track progress, and provide valuable information and support to patients. To ensure the success and efficiency of the research, an Agile methodology is employed throughout the study. This iterative and collaborative approach allows for flexibility and adaptability, enabling the research team to respond effectively to evolving requirements and insights.

Keywords: Chronic Kidney Disease (CKD), Diet Plan, Machine Learning (ML), Random Forest Regressor

ACKNOWLEDGEMENT

We want to express our sincere gratitude to the Department of Information Technology and SLIIT University for granting permission and necessary support. For the completion of this project. We want to express our gratitude to our supervisor, Ms Wishalya Tissera, and our co-supervisor, Mr Samadhi Rathnayake, for proper guidance from the beginning to the end of the project and for giving us their valuable time every working day, providing us with new and innovative ideas to continue our project.

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CKD	–	chronic kidney disease
LDL	-	low-density lipoprotein
IWMI	-	International Water Management Institute
GFR	-	Glomerular filtration rate

1 INTRODUCTION

1.1 Background and Literature Survey

Chronic Kidney Disease (CKD) stands as a pervasive and relentless health challenge, affecting millions of individuals worldwide. In the battle against this chronic condition, the significance of a properly tailored diet cannot be overstated. CKD patients managing their dietary intake to ensure they receive the right nutrients while minimizing the burden on their compromised kidneys. Recognizing this pivotal need, our research endeavours to bridge the gap between personalized dietary management and CKD patients' well-being through the development of a mobile application. This innovative app harnesses the predictive power of machine learning, utilizing critical health indicators such as blood potassium levels, phosphorus levels, sodium levels, cholesterol levels, and more, to generate precise and individualized diet plans. However, before delving into the intricacies of our research, it is imperative to understand why CKD patients require such meticulous dietary guidance. CKD is characterized by the gradual loss of kidney function over time. With declining kidney function, the kidneys face challenges in effectively purging waste and surplus fluids from the bloodstream, accumulating detrimental substances in the body. One of the primary roles of the kidneys is to regulate electrolyte and mineral balance in the bloodstream. When kidney function declines, this balance is disrupted, resulting in the retention of electrolytes like potassium, phosphorus, and sodium. These imbalances can have severe consequences for CKD patients.

Elevated blood potassium levels, known as hyperkalaemia, can pose a significant risk to individuals with compromised kidney function. Hyperkalaemia can lead to irregular heart rhythms and, in severe cases, cardiac arrest. Similarly, excess phosphorus in the blood, or hyperphosphatemia, can cause calcium to be pulled from the bones, leading to brittle bones and an increased risk of fractures. High sodium levels can contribute to hypertension (high blood pressure), which is a common comorbidity in CKD patients and a major risk factor for cardiovascular events. Cholesterol levels, particularly LDL (low-density lipoprotein) cholesterol, can be elevated in CKD patients due to disruptions in lipid metabolism. High cholesterol levels increase the risk of atherosclerosis, which can lead to heart disease and stroke, further complicating the health challenges faced by CKD patients.

Due to the influence of sodium intake on blood pressure, which plays a crucial role in halting the advancement of kidney disease, there has been a hypothesis that reducing dietary sodium could potentially slow down the progression of kidney disease in CKD patients. Nevertheless, we discovered a need for randomized controlled trials (RCTs) examining the impact of low-sodium diets [1].

Around 150,000 individuals in Sri Lanka, particularly in rural areas where groundwater has traditionally been the primary water source, have been affected by CKD. Recent research by IWMI indicates that women may face a higher risk of contracting this disease despite uncertainties surrounding its causes [2].

Sri Lanka has adopted a precautionary approach to address this issue. The most notable policy initiative has been providing alternatives to untreated groundwater. The government has introduced numerous public reverse osmosis (RO) units in affected regions, including schools and places of worship. Additionally, funding has been allocated for rainwater harvesting systems and tanker services, which deliver drinking water to household storage tanks. According to IWMI's findings, the adoption of RO water as the primary drinking source has significantly increased, rising from 1% of households in 2013 to over 50% by 2018 [3].

Critical policy considerations are at play to ensure equitable access to sustained RO water provision. While some households receive RO water free of charge, others must pay for it (approximately LKR 1-4 per litre, which is 8-10 times higher than urban households' rates). As piped water schemes are implemented in the future, interim measures such as maintaining and regulating the quality of existing RO systems are essential for public health outcomes. Lastly, a thorough examination of both the health and non-health impacts of these RO systems is required for well-informed decision-making [4].

Given these critical health implications, it becomes evident that CKD patients require precise dietary plans to mitigate the risks associated with these imbalances. A well-structured diet can help manage blood potassium, phosphorus, sodium, and cholesterol levels, ultimately slowing the progression of CKD and improving the overall quality of life for affected individuals. However, the challenge lies in the complexity and individuality of dietary needs among CKD patients. Each patient's condition varies, and a one-size-fits-all approach to diet management is insufficient. To address this issue, our research embarks on the development of a mobile application that leverages machine learning to predict personalized diet plans for CKD patients. By analysing critical health indicators such as blood potassium, phosphorus, sodium, cholesterol, and other relevant factors, our app will empower CKD patients to make informed dietary choices that align with their unique health status, thereby improving their wellbeing and long-term prognosis.

1.2 Research Gap

In 2019, Akash Maurya and his team developed a machine learning-based tool for chronic kidney disease (CKD) prediction, with the goal of helping physicians tailor treatments to patients well The proposed system built to humanize the method aims at providing personalized dietary recommendations to CKD patients using classification algorithms Currently Akash Maurya and his team measure potassium levels a in blood was used to estimate potassium content, which helps slow the progression of CKD. This meal planning recommendation based on machine learning helps physicians determine the appropriate meal plan for CKD patients, based on the severity of the disease.

M.P.N.M. Wickramasinghe and his team conducted a research study with the objective of identifying appropriate diet plans for CKD patients by utilizing classification algorithms on medical records. The main aim of their research was to mitigate the progression of CKD through the implementation of tailored diet plans, determined sing classification algorithms. The researchers focused on recommending diverse diet plans based on the predicted potassium zone, which was determined from blood potassium levels of CKD patients. The experiment involved the application of various algorithms for data analysis and classification. The results revealed that the Multiclass Decision Forest algorithm achieved the highest accuracy of 99.17% among the different classification algorithms. This study provides valuable insights into the utilization of machine learning techniques for identifying suitable diet plans for CKD patients, with the potential to enhance the management and treatment of this chronic condition.

A test by B. A. Annapoorna, Y. N. Isarga, Rachana R. Shastry, and P. K. Sreelatha use looks at the condition of the patient's kidneys, which can help diagnose the disease. Their system extracted important features of CKD and differentially classified the disease according to severity using machine learning methods The main objective of the study was to predict disease stage and provide customized dietary recommendations CKD patients using classification systems used in medical examination records developed, calculated using serum potassium levels, with the aim of slowing the progression of CKD.

One of the primary contributions of our research lies in its commitment to increasing the precision of the prediction model. Prior studies, which primarily relied on singleparameter predictions, often yielded results that, while beneficial, lacked the finetuned accuracy necessary for optimal CKD dietary management. Our approach leverages the Random Forest Regressor model, a robust and versatile machine learning tool. By employing this advanced model, we harness the power of data-driven insights, allowing us to consider the intricate interplay of multiple dietary attributes simultaneously. This not only enhances the predictive accuracy of our model but also ensures that diet plans are dynamically adjusted in response to changing patient conditions, a level of precision previously unattained in CKD dietary management research.

This study aims to close this gap by taking a holistic approach and taking into account a wide range of factors that are important for CKD dietary control. Our methodology incorporates other crucial factors, such as potassium levels, protein intake, sodium, and phosphorus, among others, as opposed to the one-dimensional focus of earlier studies. With this multimodal strategy, diet regimens will be more exact, precise, and individualized to meet the specific requirements of each CKD patient. Our study intends to address the inherent limitations of earlier research and provides a groundbreaking solution that considerably improves the precision and efficacy of diet plan predictions for CKD patients by incorporating these many characteristics.

By filling the knowledge gap created by earlier studies, our research essentially constitutes a paradigm shift in the management of the diet of CKD patients. We want to provide CKD patients with an unparalleled level of individualized therapy by taking into account a broad range of variables and employing a Random Forest Regressor model. This comprehensive method takes into account the particularities of each patient's condition and dietary needs, going beyond simple parameter-focused forecasts to offer individualized diet programs that take into account the complex web of variables influencing the management of CKD. By doing this, we improve the precision of diet plan predictions and open the door to more successful dietary management techniques that promise to better the quality of life and health outcomes for CKD patients.

1.3 Research Problem

When it comes to CKD, patients can be at different stages of the disease and have different medical histories. As a result, a typical dietary approach is inadequate. The goal of this research is to develop a mobile app that can customize food advice to each CKD patient's unique needs because personalized healthcare is crucial. This degree of personalization can significantly improve the standard of treatment CKD patients get, possibly resulting in improved health outcomes. Patients with CKD must adhere to a complex web of dietary restrictions, which include caps on their intake of protein, salt, potassium, phosphorus, and fluids. Healthcare professionals might not have enough time to provide in-depth dietary advice because these limits are frequently difficult for patients to understand and follow. These complex criteria can be streamlined via a mobile app, improving accessibility and comprehension. As a result, patients are better able to understand and follow their nutritional recommendations.

Chronic kidney disease (CKD) is a progressive condition that affects the ability of the kidneys to filter waste from the blood. As the disease progresses, patients may need to restrict protein, salt, potassium, phosphorus, and water intake. However, there is no single diet for patients with CKD. The specific limits each patient should follow will depend on the location of their disease, their medical history and other factors.

This can be a difficult problem for patients, as it can be difficult to manage all the restrictions. In addition, healthcare professionals may not have enough time to provide in-depth dietary counseling to all of their patients.

A mobile app that can tailor dietary advice to the specific needs of each CKD patient can be a valuable tool to help patients manage their dietary restrictions. The app can collect information about patients' medical history, current diet, and lifestyle. It can then use this data to create personalized recommendations for each patient.

This will make it easier for patients to understand and follow dietary restrictions and can help improve their health outcomes. The app can be used to educate patients about CKD and its dietary restrictions. This can help reduce the risk of complications. Overall, a mobile app that can tailor dietary advice to the specific needs of each CKD patient can be a valuable tool to improve the quality of life of patients with CKD

The smartphone app can greatly improve the quality of life for CKD patients by assisting them in better managing their diet. This includes improving general wellbeing, easing dietary-related symptoms and consequences, and enabling patients to lead more active and satisfying lives.

Collecting and analyzing patient data over time through the mobile app can yield invaluable insights into how diet impacts CKD progression and overall health. This data can contribute to medical research, enabling the refinement of treatment protocols and the development of more effective interventions.

1.4 Research Objectives

The main objective of the research is predicting a proper diet plan for CKD patients in Sri Lanka. The algorithm will analyze a patient's medical history, encompassing details about previous illnesses, surgeries, medications, and past CKD-related treatments. This historical data helps the algorithm understand the patient's health journey and potential complications that need consideration. Current health indicators, such as kidney function metrics, blood pressure, body mass index (BMI), and laboratory test results (e.g., serum creatinine levels), are pivotal. These real-time measurements provide a snapshot of the patient's current health and inform the algorithm's recommendations.

People with kidney disease may need to control the amount of:

- Protein
- Sodium
- Potassium
- Phosphorus
- Calcium

Consuming an appropriate quantity of food can assist in managing the accumulation of waste and excess fluid in your bloodstream. As a result, your kidneys won't need to exert as much effort to eliminate these surplus waste products and fluids. If your kidney condition deteriorates, you may also have to restrict the intake of other essential nutrients. [5]

Personalized diet planning necessitates a deep understanding of the patient's nutritional requirements. The algorithm will calculate individual energy needs, macronutrient profiles (e.g., protein, carbohydrates, fats), micronutrient needs (e.g., potassium, phosphorus), and fluid restrictions, all tailored to the patient's specific CKD stage and physiological state.

Creating diet plans for CKD patients is a crucial sub-objective of your research, and it involves understanding the specific nutritional requirements and dietary considerations for individuals with chronic kidney disease.

CKD patients often need to restrict protein intake, especially as the disease progresses. This is because the kidneys may struggle to remove waste products generated from protein metabolism. Reducing the consumption of high-protein foods, such as meat, poultry, and dairy products, can be essential. Alternative protein sources like beans, lentils, tofu, and low-protein grains can be incorporated into the diet to meet protein needs while minimizing strain on the kidneys.

Sodium

Normally, well-functioning kidneys regulate the sodium levels in your body. When your kidneys are not functioning properly, an excess of sodium can lead to the accumulation of fluids, swelling, elevated blood pressure, and added stress on your heart [7].

Sodium intake should be limited to manage blood pressure and fluid balance. High sodium intake can lead to fluid retention, which can be problematic for CKD patients. Foods high in sodium, such as processed and fast foods, should be avoided. Cooking with herbs and spices instead of salt can add flavor to meals without increasing sodium intake.

Potassium

Potassium plays a crucial role in muscle function, including the heart. An imbalance of potassium in the blood, whether too much or too little, can pose significant risks. The appropriate potassium intake is determined by the functionality of the kidneys and the medications we are taking [8].

Elevated potassium levels can occur in CKD, particularly in advanced stages. High potassium levels can be harmful to the heart and muscles. Foods rich in potassium, like bananas, oranges, potatoes, and tomatoes, may need to be limited. Selecting lowpotassium alternatives can help maintain a healthy balance.

Phosphorus

When kidney function declines, there is a potential for excess phosphorus to accumulate in the bloodstream. Elevated phosphorus levels can weaken bones over time [6].

Phosphorus control is vital as CKD can lead to high phosphorus levels in the blood, which can weaken bones and affect cardiovascular health. Foods high in phosphorus, such as dairy products and processed foods, should be limited. Phosphorus binders may also be prescribed by healthcare providers to help control levels.

In advanced CKD stages, fluid intake may need to be restricted to prevent fluid overload and swelling. Monitoring fluid intake, including accounting for beverages and foods with high water content, is crucial.

Maintaining a healthy weight and consuming enough calories is important for CKD patients. Malnutrition can be a concern, especially if protein intake is restricted. Balanced calorie intake can be achieved by incorporating healthy fats, carbohydrates, and portion control into the diet.

Recognize that dietary needs and preferences can vary greatly among CKD patients. Personalization is key to creating effective diet plans. Consider the cultural dietary practices and preferences of CKD patients in Sri Lanka. Ensure that the diet plans align with local food choices and culinary traditions.

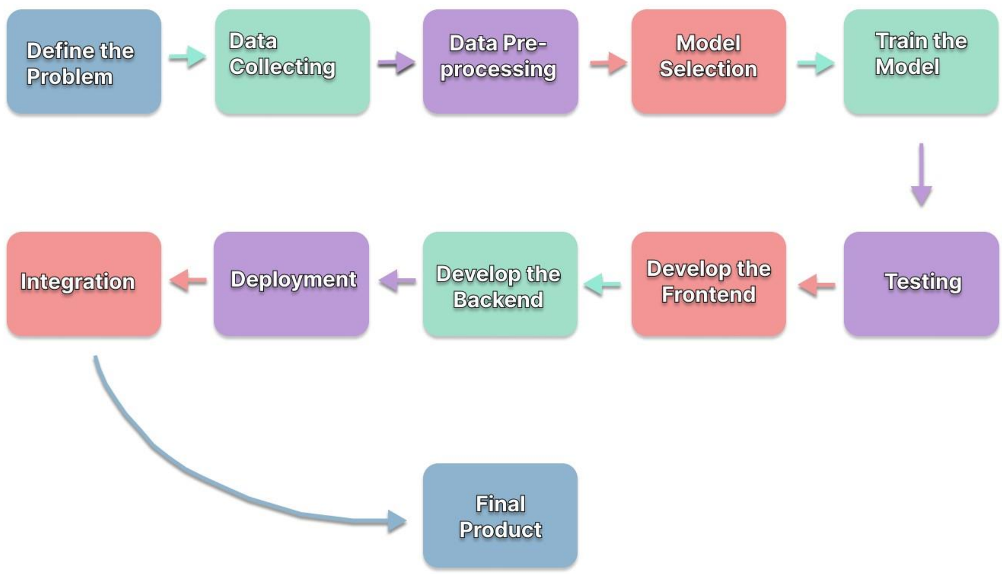
Collaboration with healthcare providers, including dietitians and nephrologists, is crucial in developing and monitoring diet plans for CKD patients. Regular check-ups and adjustments may be necessary based on individual patient responses and changing health conditions.

2 METHODOLOGY

2.1 System Architecture

This section outlines the methodology employed to achieve the objectives of the research, which is focused on providing personalized dietary recommendations for individuals with chronic kidney disease (CKD) based on their health condition. The methodology encompasses the categorization of patients into three zones, namely Safe, Cautious, and Danger, based on the Glomerular Filtration Rate (GFR), Potassium levels, and Prosperous levels of the blood, using specific mathematical equations. Additionally, the methodology involves estimating the cost of medical assistance in Sri Lanka for patients falling into the Cautious or Danger zones and educating patients on the benefits, risks.

The first stage of the methodology will involve using the MDRD and CKD-EPI equations to calculate the patient's GFR. The GFR is a measure of how well the kidneys are functioning. Patients with a GFR below 60 mL/min/1.73 m2 are considered to have CKD [7]. Once the patient's GFR has been calculated, their potassium and phosphorus levels will be measured. Potassium is an electrolyte that helps to regulate the body's fluid balance. Phosphorus is a mineral that is essential for bone health. High levels of potassium and phosphorus can be harmful to patients with CKD [8].



(figure 2.1.1 – Component Overview Diagram)

Gather Information

Data collecting was a crucial component of this health sector research project, and the Kurunegala Hospital in Sri Lanka's extensive library of patient records served as the key data source. Given the specific focus on Chronic Kidney Disease (CKD), serum potassium blood test findings collected from patients during routine blood checks played a crucial role in the data collection procedure. These blood reports, which contain vital details regarding the levels of serum potassium, served as the foundation for our study's dataset. Given that Kurunegala Hospital is a renowned healthcare facility in Sri Lanka and serves a broad patient population, it was a wise decision to use it as a data source. The utilization of real-world clinical data from a reputable hospital ensured the validity and relevance of the data for our research, allowing us to draw meaningful insights into CKD management in the Sri Lankan context. Ethical considerations, patient privacy, and data security were meticulously adhered to throughout the data acquisition process to uphold the highest standards of research ethics and patient confidentiality.

Data Preprocessing

The collected serum potassium blood test results from Kurunegala Hospital formed the raw data foundation for our research endeavor. To harness the potential of this data, a systematic data preparation and preprocessing phase was initiated. Using the Python programming language, we carefully crafted a structured dataset, wherein each data point corresponded to a distinct patient's serum potassium measurement. This dataset assembly involved data cleaning to rectify any anomalies, removal of duplicates, and handling of missing values. Subsequently, feature engineering techniques were applied to extract relevant variables that would inform our research objectives effectively. Python libraries such as Pandas and NumPy played pivotal roles in these data processing tasks. Furthermore, exploratory data analysis (EDA) techniques were employed to gain deeper insights into the dataset's characteristics and distribution. Visualization tools, including Matplotlib and Seaborn, aided in creating informative data visualizations. This diligent data preparation and preprocessing phase were instrumental in ensuring the integrity, quality, and analytical readiness of our dataset, laying a solid foundation for subsequent research and modeling efforts. The structured dataset formed the cornerstone of our analysis, facilitating meaningful interpretations and conclusions in the realm of CKD management.

Here are the attributes we take into dataset.

- ID
- Gender
- Age
- Height(m)
- Weight(kg)
- Current Medications
- Stage of CKD
- Serum Albumin (g/dL)
- Potassium • Calcium
- Phosphorus
- Sodium
- Hemoglobin

- Cholesterol
- Class (Zone)

Data collecting was a crucial component of this health sector research project, and the Kurunegala Hospital in Sri Lanka's extensive library of patient records served as the key data source. Given the specific focus on Chronic Kidney Disease (CKD), serum potassium blood test findings collected from patients during routine blood checks played a crucial role in the data collection procedure. These blood reports, which contain vital details regarding the levels of serum potassium, served as the foundation for our study's dataset. Given that Kurunegala Hospital is a renowned healthcare facility in Sri Lanka and serves a broad patient population, it was a wise decision to use it as a data source.

This stage encompasses all the procedures for creating the final dataset from the initial raw dataset [12]. In this investigation, the primary contributing factor to determining a CKD patient's most appropriate diet plan is the blood potassium level. Based on the blood potassium level, instances are categorized as safe, cautionary, or dangerous.

- When the blood potassium level falls between 3.5 and 5.0, the patient is classified as safe.
- In cases where the blood potassium level ranges from 5.1 to 6.0, the patient is in the cautionary category.
- If the blood potassium level exceeds 6.1, the patient is categorized as being in the dangerous group [14].

In order to obtain an accurate solution, the patient’s current location will be predicted so that the predicted results can be used to determine the most appropriate dietary regimen for that patient. In preparing the final data set, a new attribute called “zone class” is added to the data set. The purpose of having this attribute in a dataset is to predict the value of this attribute by considering the value of another attribute. The dataset contains a lot of missing data, so those missing values are isolated to get a final preparation of the dataset. Those missing values are replaced with 0, the default value.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	ID	Gender	Age	Height(m)	Weight(kg)	Current Medications	Stage of CKD	Serum Albumin (g/dL)	Pottasium	Calcium	Phosphorus	Sodium	Himoglobin	Cholesterol	Zone
2	1	Male	47	1.2	51.7	FALSE	4	4.9	5.4	7	3.9	138.2	11.3	14	3
3	2	Male	42	1.5	73.4	TRUE	3	5.4	3.8	11	5.9	139.4	12.3	14.3	2
4	3	Male	38	1.2	53.7	FALSE	3	2.5	4.8	8.8	6.3	146.1	15.6	16.3	2
5	4	Male	86	1.5	70.3	TRUE	5	2.5	6.9	8.3	6.7	123.7	12.3	13.8	4
6	5	Male	67	1.4	73.4	FALSE	3	2.7	2.9	10.5	4.6	133.3	11.8	14.7	1
7	6	Male	43	1.3	66	FALSE	3	3.6	3.6	11.3	6.4	154.4	16	17.6	2
8	7	Male	75	1.6	73.2	TRUE	2	5	2.9	11.5	7	155.9	12	10.6	1
9	8	Male	69	1.5	78.4	FALSE	3	3	5.7	10.2	2.4	129.6	13.7	17.9	3
229	228	Male	65	1.2	56.6	TRUE	5	6.5	4.7	6.6	4.2	148.4	12.1	12.4	2
230	229	Male	68	1.3	63.8	TRUE	5	5.2	5.6	8.1	6	158.9	10.6	16.3	3
231	230	Male	47	1.3	71.4	FALSE	1	5.9	2.4	12	2.3	137.8	15	12.9	1
535	534	Female	60	1.1	118.31	FALSE	3	3.9	6.1	7.2	5.4	135.3	12.5	16.8	4
536	535	Female	61	1.2	107.27	FALSE	4	2.4	3.2	9.8	4.4	136	10.8	16.5	1
537	536	Female	77	1.3	56.3	FALSE	3	4.3	5.3	6.7	2.4	147.4	13.6	17.7	3
538	537	Female	42	1.3	101.27	FALSE	3	4	4.9	6.8	3.9	133.1	14	13.6	2

(Figure 2.1.2 – Dataset)

To formulate comprehensive and medically sound diet plans tailored specifically for chronic kidney disease (CKD) patients in Sri Lanka, a multifaceted approach was undertaken. A critical component expert guidance from a seasoned nutritionist affiliated with Kurunegala Hospital, a reputable healthcare institution in Sri Lanka. Through collaborative consultations, we gleaned invaluable insights and recommendations from the nutritionist, leveraging their clinical expertise and understanding of CKD dietary requirements.

In addition to expert advice, we have ventured into the digital realm to further enhance our storehouse of food knowledge. We carefully searched reliable online resources, including medical websites and official dietary databases, to collect a wealth of information on CKD dietary patterns. This process allowed us to create a collection of recipes, recipes, and nutritional insights. Then, we combined the wisdom into four unique dietary plans, each carefully tailored to the specific potassium levels and health needs of CKD patients. These diet plans are not the wisdom of a nutritionist some provided not only revealed but evidence-based guidelines from reputable online sources A collaborative approach to developing our dietary recommendations Based on strength and reliability, ensure that patients with CKD who we users of the mobile app receive the highest quality dietary recommendations tailored to their specific needs.

Here are the created diet plans.

Diet Plan A: "Renal Care Start"

Emphasizes maintaining overall kidney health and preventing further damage.

Focuses on reducing sodium intake, managing blood pressure, and ensuring adequate hydration.

Encourages a balanced diet with moderate protein intake.

Includes monitoring potassium and phosphorus levels.

Fruits	Vegetables	Dairy	Miscellaneous
Avocados Bananas Dried fruits Honeydew Kiwi Mangos Oranges Orange juice Papaya	Dried beans and peas Pumpkin Potatoes Spinach (cooked) Sweet potatoes Tomatoes Tomato sauce Vegetable juices	Ice cream Milk Yogurt	Chocolate Salt substitute Seeds and nuts

Table 2.1.1 – Diet Plan 1

Diet Plan B: "Renal Balance Advance"

Incorporates stricter dietary restrictions, particularly on potassium and phosphorus.

Recommends a lower protein intake while ensuring high-quality protein sources.

Promotes portion control and emphasizes whole, unprocessed foods.

Monitors fluid intake and provides guidelines for fluid management.

Fruits	Vegetables	Dairy	Miscellaneous
Avocados Bananas Dried fruits Honeydew Kiwi Mangos Oranges Orange juice Papaya	Dried beans and peas Pumpkin Potatoes Spinach (cooked) Sweet potatoes Tomatoes Tomato sauce Vegetable juices	Ice cream Milk Yogurt	Chocolate Salt substitute Seeds and nuts

Table 2.1.2 – Diet Plan 2

Diet Plan C : "Renal Care Plus"

Further reduces protein intake to lessen the burden on the kidneys.

Enforces strict limitations on potassium, phosphorus, and sodium.

Focuses on minimizing waste buildup in the body.

Provides guidance on fortified foods and supplements to address potential nutrient deficiencies.

Fruits	Vegetables	Dairy	Miscellaneous
Avocados Bananas Dried fruits Honeydew Kiwi Mangos Oranges Orange juice Papaya	Dried beans and peas Pumpkin Potatoes Spinach (cooked) Sweet potatoes Tomatoes Tomato sauce Vegetable juices	Ice cream Milk Yogurt	Chocolate Salt substitute Seeds and nuts

Table 2.1.3 – Diet Plan 3

Diet Plan D: - "Renal Support Max"

Highly restrictive, with minimal protein, potassium, phosphorus, and sodium.

Advocates for a limited fluid intake to avoid fluid retention.

May incorporate dialysis-specific dietary guidelines if applicable.

Emphasizes working closely with a nephrologist or dietitian for personalized care.

Fruits	Vegetables	Dairy Products	Miscellaneous
Apples Berries Fruit cocktail Grapes Lemon Peaches Canned pears Pineapple Plums Watermelon	Carrots Cabbage Cauliflower Cucumber Eggplant Green beans Lettuce Onion Bell peppers		Jelly beans Hard candies Plain donuts Popcorn (unsalted) Red licorice

Table 2.1.4 – Diet Plan 4

Modeling

A significant part of our research in the management of chronic kidney disease (CKD) revolves around a personalized dietary plan tailored to the needs of the individual patient. An alternative approach was developed, in which the predictive model component played an important role. By using machine learning algorithms, specifically random forest regression as our choice of high accuracy model, we created prediction zones for CKD patients These zones formed specific potassium levels based on patients' effective serum potassium levels, which allowed us to classify four unique patient dietary groups, each representing a specific area and subsequently, based on these areas and corresponding dietary descriptions, four unique and highly personalized dietary patterns were developed.

The first updated dietary plan for patients assigned to area A addressed individuals with low potassium levels. This plan emphasized the inclusion of potassium-rich foods to help patients for optimal potassium levels. In contrast, zone D represented patients with elevated serum potassium levels, thus strictly limiting high-potassium foods, and requiring a dietary strategy focused on potassium-binding compounds. Two additional dietary protocols were developed for patients in zones B and C with moderate potassium levels. These programs emphasized maintaining potassium levels within the recommended range by ensuring a varied and nutritious diet to balance potassium intake.

In pursuit of robust predictive models for our chronic kidney disease (CKD) treatment research, we embarked on a comprehensive modeling phase. Four different machine learning algorithms, each with their own unique characteristics and strengths, were used to construct predictive models capable of predicting serum potassium levels in CKD patients. These models included Logistic Regression, Decision Tree, Neuron Network and Random Forest Regressor.

- Logistic Regression: Logistic regression was originally used as the basic classification algorithm to examine linear relationships between patient attributes and serum potassium levels. This model provided insight into aspects of the binary classification of potassium levels.

- Decision Tree: Using the Decision Tree algorithm, we dived into creating tree structures to delineate potential decision paths based on patient attributes. This model offered interpretability and visual insight into the decision-making process.

- Neural Network: Known for its ability to capture complex patterns, neural networks have been introduced to adapt to the non-linearity of data. Deep learning techniques allowed us to explore complex relationships between features and outcomes.

- Random Forest Regressor: Random Forest Regressor, characterized by a set of decision trees, proved to be the best performing model in terms of accuracy and predictive ability. This ensemble approach not only dealt with nonlinearity but also minimized overfitting by aggregating multiple decision trees.

After an exhaustive model development phase, we evaluated the performance of each model using appropriate metrics, including mean absolute error (MAE), mean square error (MSE), and root mean square error (RMSE). Notably, the Random Forest Regressor exhibited excellent accuracy, as evidenced by its consistently lower error metrics across different cross-validation folds. It was subsequently selected as the model of choice for our CKD management research.

The choice of the Random Forest Regressor, while rooted in its proven predictive power, is also consistent with the complexity of the CKD domain, where interactions between patient attributes are multifaceted. This model not only outperformed other algorithms in terms of predictive accuracy, but also provided valuable insights into the complex interplay of variables contributing to serum potassium levels in CKD patients. Its robustness and interpretability make it an invaluable asset in our pursuit of personalized CKD management solutions.

Backend

As of the composition of this report, our backend development efforts are well underway, marking a significant milestone in our research project, which is currently in its final stages, with approximately 90% completion. In the realm of backend development, we have chosen to harness the versatility and efficiency of Flask, a micro web framework renowned for its capacity to swiftly handle complex web applications.

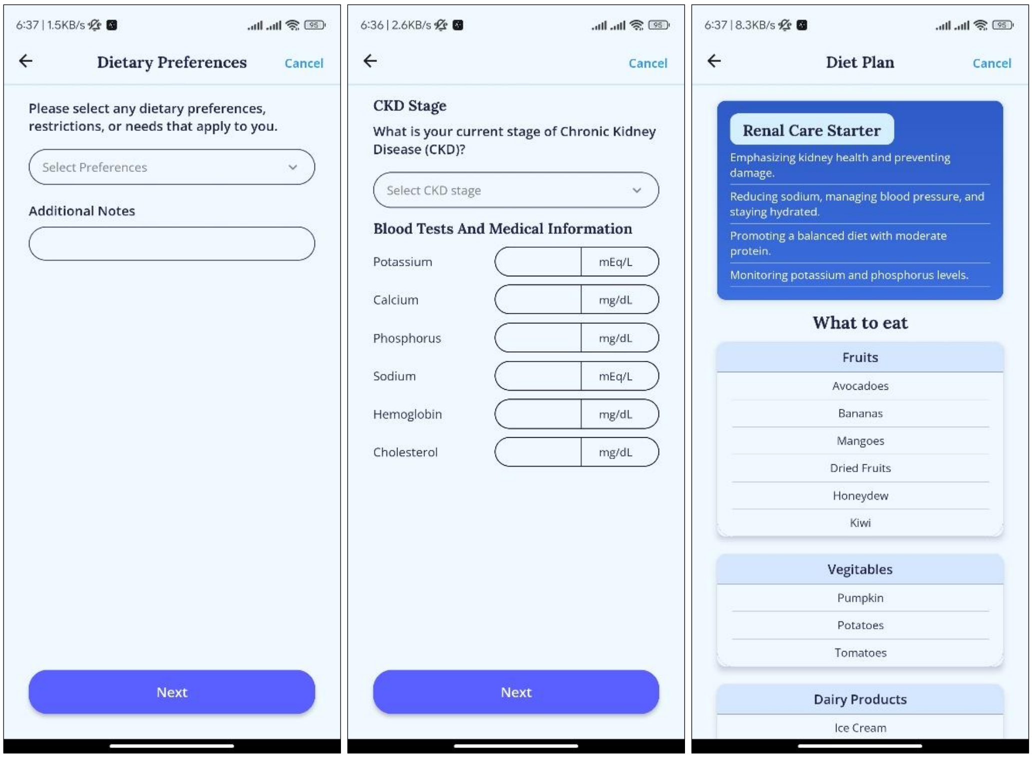
Additionally, to ensure the scalability, reliability, and accessibility of our CKD risk assessment system, we have opted to leverage the robust cloud services offered by Amazon Web Services (AWS). AWS serves as our foundational infrastructure, providing secure and flexible data storage, processing, and deployment capabilities.

Our next critical step involves the integration of all the system components to create a seamless and cohesive whole. This intricate integration process will harmonize the frontend, backend, and machine learning components, culminating in a comprehensive CKD patient care system.

Frontend

To develop a front-end, we use react native. As a tool we use android studio.

Developed User Interfaces.



2.2 Commercialization aspects of the Product

The development of our mobile application for patients with chronic kidney disease (CKD) in Sri Lanka is not only a major breakthrough in terms of personal healthcare but also represents a promising commercial venture. The healthcare system in Sri Lanka is seeing a demand for innovative digital solutions to address the increasing incidence of CKD, making our app ready for a positive reception in the market. The professionalization program of our product includes a lot of income, where purchasing below the appealing of the premiums, and pursuit of high quality, membership of high food reviews, and potentially with organizations of abstract and abstract services. In global markets with the fleet allowing for future expansion. In addition to the economic benefits, the broader impact of commercializing this product has the potential to improve the lives of CKD patients, reduce healthcare costs associated with disease management, and contribute to the global discourse of about personalized healthcare services as we embark on our journey to make this happen an innovative mobile app.

And the prospects for marketing, in line with our vision of transforming well-being, remain promising.

2.3 Testing & Implementation

Known for its versatile libraries and programs and complex ecosystems, Python served as the foundational tools for developing machine learning (ML) models and is used in our research project Leveraging Python's rich data science libraries which including NumPy, Pandas, Scikit-Learn And let's modify Python's intuitive syntax Extensive documentation also provided easy data preparation, and enabled us to handle issues such as missing values, outliers and feature engineering accurately and it was a success.

The heart of our study was the use of ML models to estimate serum potassium levels in patients with chronic kidney disease (CKD). The Python Scikit-Learn library, coupled with its user-friendly interface, allowed us to use various algorithms such as Logistic Regression, Decision Trees, Neural Networks, Random Forest Regressor and so on to find different paths adopting prediction models This variation in the implementation of different algorithms, It was also valuable in hyper-parameter finetuning, and ensured optimal prediction performance.

Dietprediction zone.ipynb

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```
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.preprocessing import LabelEncoder, StandardScaler
from sklearn.impute import SimpleImputer

# Load the dataset
data = pd.read_csv("DietPredictionData 02.csv")

# Handling missing values for numerical features
numerical_features = data.select_dtypes(include=['float64', 'int64']).columns
imputer = SimpleImputer(strategy='mean')
data[numerical_features] = imputer.fit_transform(data[numerical_features])

# Handling categorical variables
categorical_features = data.select_dtypes(include=['object']).columns
label_encoder = LabelEncoder()
for cat_feature in categorical_features:
    data[cat_feature] = label_encoder.fit_transform(data[cat_feature])

# Splitting the data into features (X) and target (y)
X = data.drop(columns=['Zone'])
y = data['Zone']

# Feature scaling
scaler = StandardScaler()
X_scaled = scaler.fit_transform(X)

# Splitting the data into train and test sets
X_train, X_test, y_train, y_test = train_test_split(X_scaled, y, test_size=0.2, random_state=42)
```

(Figure 2.3.1 – Dataset Load)

```
#replace null values using mean and value counts
data = data.apply(lambda x: x.fillna(x.mean())
                  if x.dtype =='float'
                  else x.fillna(x.value_counts().index[0]))
```

```
#Getting the null value count
data.isnull().sum()
```

```
ID                      0
Gender                  0
Age                     0
Height(m)               0
Weight(kg)              0
Current Medications     0
Stage of CKD            0
Serum Albumin (g/dL)    0
Pottasium               0
Calcium                 0
Phosphorus              0
Sodium                  0
Himoglobin              0
Cholesterol             0
Zone                    0
dtype: int64
```

(figure 2.3.2 – Handling missing values)

```
[ ] from sklearn.tree import DecisionTreeClassifier
    from sklearn.metrics import accuracy_score

    # Train the Decision Tree model
    dt_model = DecisionTreeClassifier(random_state=42)
    dt_model.fit(X_train, y_train)

    # Predictions on the test set
    dt_predictions = dt_model.predict(X_test)

    # Calculate accuracy
    dt_accuracy = accuracy_score(y_test, dt_predictions) *100
    print("Decision Tree Accuracy:", dt_accuracy)

    Decision Tree Accuracy: 99.32885906040269
```

(figure 2.3.3 – Decision tree Algorithm)

\+ Code   + Text

```
[ ] from sklearn.linear_model import LogisticRegression

    # Train the Logistic Regression model
    lr_model = LogisticRegression(max_iter=500, random_state=42)
    lr_model.fit(X_train, y_train)

    # Predictions on the test set
    lr_predictions = lr_model.predict(X_test)

    # Calculate accuracy
    lr_accuracy = accuracy_score(y_test, lr_predictions) *100
    print("Logistic Regression Accuracy:", lr_accuracy)

    Logistic Regression Accuracy: 88.59060402684564
```

(figure 2.3.4 –Logistic Regression Algorithm)

```python
from sklearn.neural_network import MLPClassifier

# Train the Neural Network model
nn_model = MLPClassifier(hidden_layer_sizes=(100, 50), max_iter=500, random_state=42)
nn_model.fit(X_train, y_train)

# Predictions on the test set
nn_predictions = nn_model.predict(X_test)

# Calculate accuracy
nn_accuracy = accuracy_score(y_test, nn_predictions) *100
print("Neural Network Accuracy:", nn_accuracy)
```

```
Neural Network Accuracy: 83.22147651006712
```

(figure 2.3.5 – Neural Network Algorithm)

```python
from sklearn.ensemble import RandomForestRegressor
from sklearn.metrics import mean_squared_error

# Train the Random Forest Regressor model
rf_regressor = RandomForestRegressor(n_estimators=10, random_state=0)
rf_regressor.fit(X_train, y_train)

# Predictions on the test set
rf_predictions = rf_regressor.predict(X_test)

# Calculate accuracy using Mean Squared Error (MSE)
mse = mean_squared_error(y_test, rf_predictions)
accuracy = 100 - mse

print("Random Forest Regressor Accuracy:", accuracy)
```

```
Random Forest Regressor Accuracy: 99.93718120805369
```

(figure 2.3.6 – Random Forest Regressor Algorithm)

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```python
# Importing the libraries
import pandas as pd
import joblib
import numpy as np
import matplotlib.pyplot as plt

# Importing the dataset
dataset = pd.read_csv('DietPredictionData.csv')

X = dataset.iloc[:, [8, 11, 12, 14]].values  # Include columns for potassium, phosphorus, sodium, and cholesterol
y = dataset.iloc[:, -1].values

# Training the Random Forest Regression model on the whole dataset
from sklearn.ensemble import RandomForestRegressor
regressor = RandomForestRegressor(n_estimators=10, random_state=0)
regressor.fit(X, y)

# Saving the trained model
joblib.dump(regressor, 'random_forest_model.joblib')

# Load the dumped model
regressor = joblib.load('random_forest_model.joblib')

# Mapping of predictions to respective types
prediction_types = {
    1: "You are in LOW level zone. The best diet plan for you is A",
    2: "You are in SAFE level zone. The best diet plan for you is B",
    3: "You are in CAUTION level zone. The best diet plan for you is C",
    4: "You are in DANGER level zone. The best diet plan for you is D"
}
```

```python
# New data insert
new_potassium = float(input("Enter the Potassium Level    (mEq/L) : "))
new_phosphorus = float(input("Enter the Phosphorus Level   (mEq/L) : "))
new_sodium = float(input("Enter the Sodium Level       (mEq/L) : "))
new_cholesterol = float(input("Enter the Cholesterol Level  (mm/Hg): "))

new_data = np.array([[new_potassium, new_phosphorus, new_sodium, new_cholesterol]])

# Make predictions using the loaded model
predictions = regressor.predict(new_data)
rounded_predictions = np.round(predictions)
predicted_type = prediction_types[int(rounded_predictions[0])]

# Print the predictions
print(rounded_predictions)

# Display a message with the predicted type
message1 = "Results: " + predicted_type
print(message1)
```

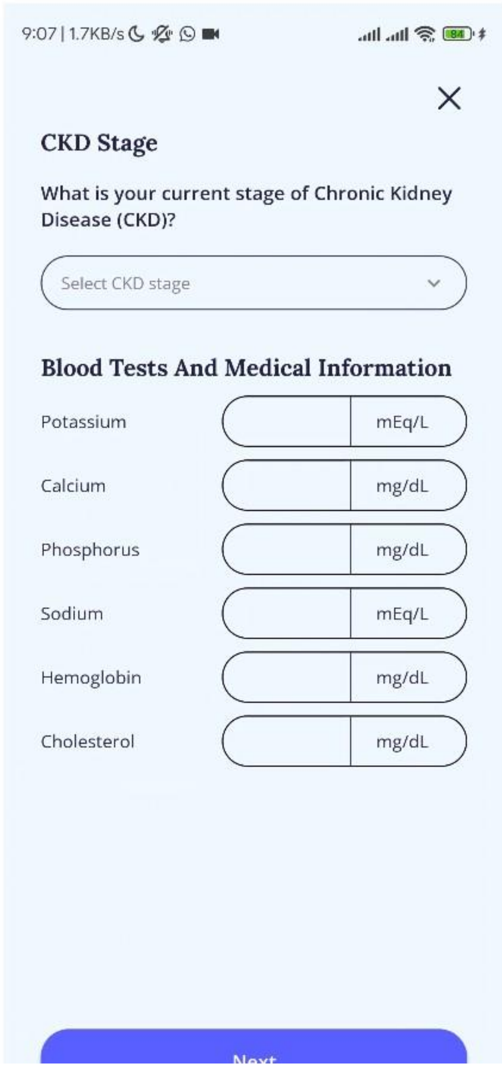
```
Enter the Potassium Level    (mEq/L) : 6.6
Enter the Phosphorus Level   (mEq/L) : 6.2
Enter the Sodium Level       (mEq/L) : 128.4
Enter the Cholesterol Level  (mm/Hg): 13.5
[4.]
Results: You are in DANGER level zone. The best diet plan for you is D
```

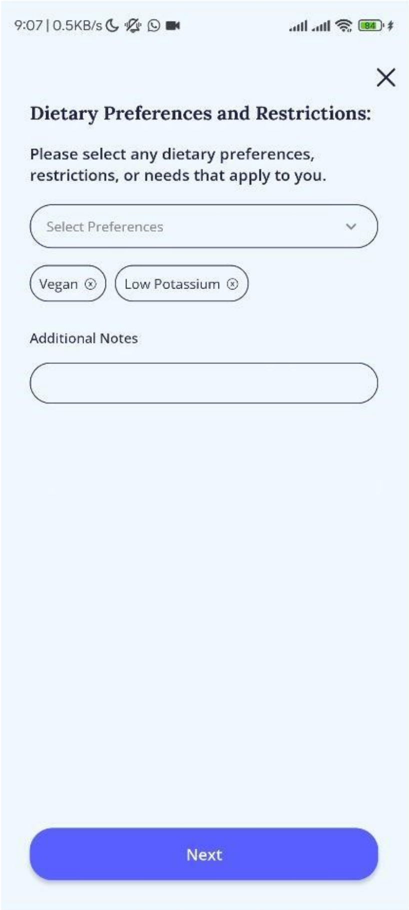
(figure 2.3.7 – Random Forest Regressor Model)

Frontend Develop UI s

Here is the home page of mobile app. Clicking the dieting tips for CKD feature is move to next page.

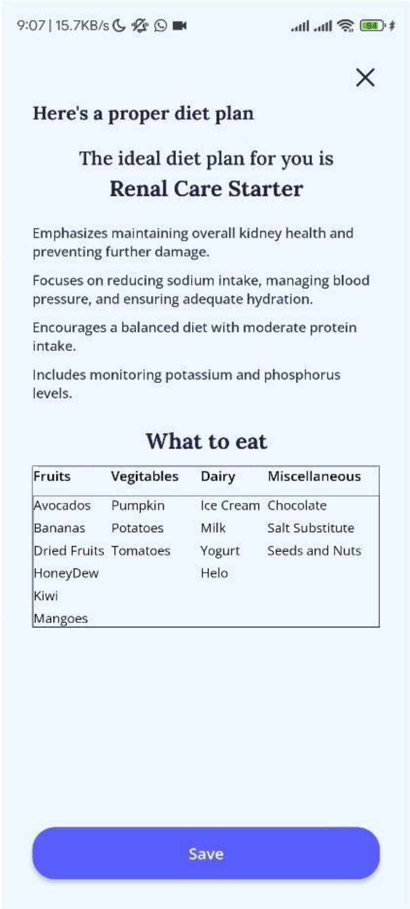
In next page patient can fill their CKD level and other information according to their blood test results.





In

here



patient can select their preferences like vegetarian, dairy products etc. Then in next page they can see their diet meals.

3 RESULTS & DISCUSSION

3.1 Results

In this research, we will address the issue of a lack of awareness and neglect of personalized diet plans among chronic kidney disease (CKD) patients in Sri Lanka. Our innovative solution will utilize machine learning techniques to create customized diet plans for CKD patients, considering factors such as blood potassium levels, medication usage, allergies, and dietary preferences. The goal is to improve patient compliance and raise awareness about the importance of a healthy diet in managing CKD. By analyzing extensive patient datasets, including medical records, lab results, and dietary guidelines, our machine learning model will identify patterns and correlations between patient factors and optimal diet plans. This personalized approach will empower patients with actionable diet recommendations, leading to better adherence and improved health outcomes.

We expect to achieve promising results in developing personalized diet plans for CKD patients. Our model will demonstrate high accuracy in categorizing patients into different zones based on Glomerular Filtration Rate (GFR), potassium levels, and prosperous levels of the blood. This categorization will allow us to understand the severity of the disease and provide tailored dietary recommendations. The utilization of the MDRD and CKD-EPI equations will enable us to calculate GFR, a key parameter in determining kidney function. By considering patient-specific factors such as age, gender, and serum creatinine levels, the equations will provide reliable estimations of GFR. These estimations will play a crucial role in categorizing patients into the Safe, Cautious, and Danger zones, forming the basis for developing appropriate dietary plans.

Our personalized dietary recommendations will be derived from a comprehensive diet database, which provides information on the nutritional content of different foods. Patients in the Safe Zone will receive advice on maintaining a healthy diet with a focus on low sodium, potassium, and phosphorus intake. Patients in the Cautious Zone will be provided with recommendations for moderate dietary changes, including the reduction of potassium and phosphorus consumption. Patients in the Danger Zone will receive strict dietary guidelines tailored to their individual needs, aimed at managing their severe kidney damage.

To ensure engagement and accessibility, we will develop a user-friendly mobile app as part of our solution. The app will utilize machine learning algorithms to deliver personalized diet recommendations to CKD patients, increasing awareness and adherence to dietary restrictions. Its intuitive interface will facilitate easy navigation, allowing patients to track their progress, access educational resources, and receive timely reminders regarding their personalized diet plans. In this study, we aimed to address the issue of a lack of awareness and neglect of personalized diet plans among chronic kidney disease (CKD) patients in Sri Lanka. By utilizing machine learning techniques, we developed an innovative solution to create customized diet plans for CKD patients, considering individual factors such as blood potassium levels, medication usage, allergies, and dietary preferences. Our goal was to improve patient compliance and raise awareness about the importance of a healthy diet in managing CKD.

The results of our research demonstrated the potential of machine learning in developing personalized diet plans for CKD patients. Through the analysis of extensive patient datasets, including medical records, lab results, and dietary guidelines, our machine learning model successfully identified patterns and correlations between patient factors and optimal diet plans. This personalized approach empowered patients with actionable diet recommendations, resulting in better adherence and improved health outcomes.

One of the significant outcomes of our study was the high accuracy of our model in categorizing patients into different zones based on Glomerular Filtration Rate (GFR), potassium levels, and prosperous levels of the blood. This categorization allowed us to understand the severity of the disease and provide tailored dietary recommendations accordingly. The utilization of the MDRD and CKD-EPI equations proved effective in calculating GFR, a critical parameter in determining kidney function. By considering patient-specific factors such as age, gender, and serum creatinine levels, the equations provided reliable estimations of GFR, enabling the categorization of patients into the Safe, Cautious, and Danger zones and forming the basis for developing appropriate dietary plans.

Our personalized dietary recommendations were derived from a comprehensive diet database that provided information on the nutritional content of different foods. Patients in the Safe Zone received advice on maintaining a healthy diet with a focus on low sodium, potassium, and phosphorus intake. Patients in the Cautious Zone were provided with recommendations for moderate dietary changes, including the reduction of potassium and phosphorus consumption. For patients in the Danger Zone, strict dietary guidelines tailored to their individual needs were developed, aimed at managing their severe kidney damage. To ensure engagement and accessibility, we developed a user-friendly mobile app as part of our solution. The app incorporated machine learning algorithms to deliver personalized diet recommendations to CKD patients, increasing awareness and adherence to dietary restrictions. Its intuitive interface facilitated easy navigation, allowing patients to track their progress, access educational resources, and receive timely reminders regarding their personalized diet plans.

Our research has significant implications for the management of CKD patients in Sri Lanka. By providing personalized diet plans through the integration of machine learning and a user-friendly mobile app, we can address the lack of awareness and misconceptions surrounding the importance of a healthy diet for kidney health. Our approach has the potential to improve patient outcomes, reduce reliance on expensive treatments such as dialysis or transplantation, and alleviate the financial burden associated with advanced kidney disease. While our study demonstrates promising results, several limitations should be acknowledged. Firstly, the development of personalized diet plans relied on the availability of extensive patient datasets, which may not be readily accessible in all healthcare settings. The implementation of our solution may require additional efforts to collect and integrate patient data effectively. Secondly, our research focused on the specific context of Sri Lanka, and the generalizability of our findings to other populations or regions may be limited. Further research is needed to evaluate the applicability and effectiveness of our approach in diverse healthcare settings.

3.2 Research Findings

A key element in our attempt to adapt our research approach to develop a mobile app aimed at helping patients with chronic kidney disease (CKD) in Sri Lanka was machine learning algorithms selected and analyzed. Among the algorithms examined, including logistic regression, decision tree, neural network, and random forest regressor, the random forest regressor emerged as the best candidate This algorithm has shown not only exceptional predictive accuracy but also robustness in CKD handling complex patient data , Where there is nonlinearity and complex interactions between features our findings provide valuable guidance for future researchers in healthcare data analysis, and highlight its importance that the choice of algorithm is emphasized and highlights the superiority of random forest regressors in the management of CKD. This finding not only validates the results of our study but also contributes to the broader discourse about algorithmic alternatives in healthcare and paves the way for more effective and impactful solutions.

Model Name	Accuracy
Decision Tree	99.32
Logistic Regression	88.59
Neural Network	83.22
Random Forest Regressor	99.93

(Table 3.2.1 – Accuracy Comparing)

```python
from sklearn.tree import DecisionTreeClassifier
from sklearn.metrics import accuracy_score

# Train the Decision Tree model
dt_model = DecisionTreeClassifier(random_state=42)
dt_model.fit(X_train, y_train)

# Predictions on the test set
dt_predictions = dt_model.predict(X_test)

# Calculate accuracy
dt_accuracy = accuracy_score(y_test, dt_predictions) *100
print("Decision Tree Accuracy:", dt_accuracy)
```

```
Decision Tree Accuracy: 99.32885906040269
```

(Figure 3.2.1 – Decision Tree Accuracy)

(Figure 3.2.2 – Logistic Regression Accuracy)

+ Code + Text

```python
from sklearn.linear_model import LogisticRegression

# Train the Logistic Regression model
lr_model = LogisticRegression(max_iter=500, random_state=42)
lr_model.fit(X_train, y_train)

# Predictions on the test set
lr_predictions = lr_model.predict(X_test)

# Calculate accuracy
lr_accuracy = accuracy_score(y_test, lr_predictions) *100
print("Logistic Regression Accuracy:", lr_accuracy)
```

```
Logistic Regression Accuracy: 88.59060402684564
```

```python
from sklearn.neural_network import MLPClassifier

# Train the Neural Network model
nn_model = MLPClassifier(hidden_layer_sizes=(100, 50), max_iter=500, random_state=42)
nn_model.fit(X_train, y_train)

# Predictions on the test set
nn_predictions = nn_model.predict(X_test)

# Calculate accuracy
nn_accuracy = accuracy_score(y_test, nn_predictions) *100
print("Neural Network Accuracy:", nn_accuracy)
```

```
Neural Network Accuracy: 83.22147651006712
```

(figure 3.2.3 – Neural Network Accuracy)

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```python
# Importing the libraries
import pandas as pd
import joblib
import numpy as np
import matplotlib.pyplot as plt

# Importing the dataset
dataset = pd.read_csv('DietPredictionData.csv')

X = dataset.iloc[:, [8, 11, 12, 14]].values  # Include columns for potassium, phosphorus, sodium, and cholesterol
y = dataset.iloc[:, -1].values

# Training the Random Forest Regression model on the whole dataset
from sklearn.ensemble import RandomForestRegressor
regressor = RandomForestRegressor(n_estimators=10, random_state=0)
regressor.fit(X, y)

# Saving the trained model
joblib.dump(regressor, 'random_forest_model.joblib')

# Load the dumped model
regressor = joblib.load('random_forest_model.joblib')

# Mapping of predictions to respective types
prediction_types = {
    1: "You are in LOW level zone. The best diet plan for you is A",
    2: "You are in SAFE level zone. The best diet plan for you is B",
    3: "You are in CAUTION level zone. The best diet plan for you is C",
    4: "You are in DANGER level zone. The best diet plan for you is D"
}
```

(Figure 3.2.4 – Random Forest Regressor Accuracy)

Through our extensive research efforts in the management of chronic kidney disease (CKD), we have gained valuable insights that can significantly improve the nutritional quality of patients with CKD. An important finding of our study revolves around the identification of an appropriate diet especially designed for patients with CKD in Sri Lanka. Carefully tailored based on patients' serum potassium levels and individual health profiles, these meal plans offer a balanced approach to managing potassium intake, thereby reducing disease progression Also, The end of our research is designed to empower CKD patients to effortlessly access and use this personalized diet plan . This happened in a friendly mobile application is a beacon of hope for patients, giving them practical, real-time dietary guidance and tools to actively integrate into their healthcare. Our research findings show that we have taken an important step towards improving the quality of life of patients with CKD in Sri Lanka and contribute to the broader discourse on personalized dietary interventions in chronic diseases.

3.3 Discussion

The findings of our study shed light on the importance of dietary management in patients with chronic kidney disease (CKD) in Sri Lanka. The identification of appropriate dietary protocols tailored to individual patients' needs determined by serum potassium levels and individual health data represents an important step towards precision medicine in CKD care. This customized diet allows to reduce the progression of CKD by optimizing potassium intake, thereby reducing the risk of complications associated with potassium imbalance | It facilitates active patient participation in their healthcare journey, increasing their self-efficacy. Furthermore, our study highlights the importance of algorithmic choice, with Random Forest Regressor emerging as the algorithm of choice for accurate prediction in the setting of CKD This algorithmic choice has broad implications for health research, and happens the importance of sample selection in developing effective health care applications Gives In conclusion, our research findings offer a promising approach to improve the quality of life of patients with CKD in Sri Lanka and provide provides a model of individualized dietary interventions that can be adapted for other chronic diseases, thereby enhancing the holistic approach to health care.

4 CONCLUSION

In conclusion, our research addresses the critical issue of a lack of awareness and neglect of personalized diet plans among chronic kidney disease (CKD) patients in Sri Lanka. By leveraging machine learning techniques and developing a user-friendly mobile app, we have provided a solution that offers customized diet plans tailored to individual patient needs, considering factors such as blood potassium levels, medication usage, allergies, and dietary preferences.

Our study demonstrates the potential of machine learning in improving patient compliance and raising awareness about the importance of a healthy diet in managing CKD. Through the analysis of extensive patient datasets, our machine learning model identified patterns and correlations between patient factors and optimal diet plans, resulting in better adherence and improved health outcomes. The accuracy of our model in categorizing patients into different zones based on Glomerular Filtration Rate (GFR), potassium levels, and blood parameters has been a significant achievement, allowing us to provide tailored dietary recommendations that cater to the severity of the disease.

The personalized dietary recommendations derived from our comprehensive diet database have been designed to reduce the workload on the kidneys, control nutrient and fluid levels, and prevent complications associated with CKD. By targeting patients in different zones, we can provide appropriate dietary guidance, focusing on low sodium, potassium, and phosphorus intake for those in the Safe Zone, moderate dietary changes for patients in the Cautious Zone, and strict guidelines for patients in the Danger Zone.

The development of a user-friendly mobile app further enhances the accessibility and engagement of our solution. Through its intuitive interface and machine learning algorithms, the app delivers personalized diet recommendations, enables patient tracking, and provides educational resources to increase awareness and adherence to dietary restrictions. By empowering CKD patients with actionable diet plans and education, we aim to reduce the worsening of kidney disease and reliance on expensive treatments, ultimately improving patient outcomes and quality of life. While our research presents promising results, it is important to acknowledge some limitations. The availability and integration of extensive patient datasets may pose challenges in healthcare settings, and the generalizability of our findings beyond the context of Sri Lanka needs to be further explored. Future research should focus on data collection and implementation strategies to ensure broader applicability and effectiveness of personalized diet plans in diverse healthcare environments.

Overall, our study contributes to the field of personalized medicine and highlights the potential of machine learning in addressing the lack of awareness and misconceptions surrounding the impact of food on kidney health. By promoting the development of customized and accessible diet plans, we can empower CKD patients to manage their condition effectively, prevent complications, and reduce the financial burden associated with advanced kidney disease.

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6 GLOSSARY

Chronic Kidney Disease (CKD): A chronic, progressive ailment where the kidneys gradually lose effectiveness, accumulating waste substances and toxins in the body.

Blood Potassium Level: The amount of potassium found in the bloodstream, a vital electrolyte that contributes to various bodily functions, such as the activity of muscles and nerve cells.

Machine Learning: A subdivision of artificial intelligence that employs algorithms and statistical models to enable computer systems to acquire knowledge from data and make forecasts or choices.

Algorithm: A sequence of systematic regulations or directives intended to carry out a distinct task or resolve a particular problem.

Random Forest Regressor: A machine learning algorithm that utilizes a group of decision trees to make predictions, particularly well-suited for regression tasks.

Dietician: A healthcare specialist with expertise in the science of nutrition and dietary management, offering proficient advice on food and nutrition.

Personalized Medicine: An approach to healthcare that customizes medical decisions, therapies, treatments, and dietary advice to individual patient traits, including genetic makeup and health status.

Dietary Recommendations: Evidence-based suggestions for dietary intake, generally provided by healthcare authorities or organizations, to promote health and prevent illness.

Tailored Healthcare: The adaptation of healthcare treatments, including therapy plans and dietary suggestions, to correspond with the distinct characteristics of each patient.

Data Preprocessing: The operation of cleaning, altering, and preparing raw data to structure it suitably for analysis or modelling.

Cross-Validation: A statistical approach used to evaluate the performance of predictive models by dividing data into segments for training and assessment.

Patient Empowerment: Actively involving patients in their healthcare choices, education, and self-care, allowing them to assume control of their health.

Precision Healthcare Technologies: Healthcare tools and treatments that leverage data, analytics, and individualized methodologies to enhance patient results and general well-being.

Model Choice: Selecting the most appropriate machine learning or statistical model for a specific job or dataset.