

**DESIGN AND AUTOMATION OF THE FOOD EXCHANGE LIST FOR MEAL
PLANNING AMONG NUTRITIONISTS IN KENYA.**

BY

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DECLARATION

I declare that this research thesis is my original work and has not been presented in any other university

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DEDICATION

I would like to dedicate this study to my loving father Romano Omwoyo and mother Marion Areba who have always been supportive to me in every step of the thesis.

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I would like to thank the Lord for this opportunity and capability to undertake this thesis. Secondly, I would like to express my sincere gratitude to my supervisors Dr. Job Mapesa and Ms. Rose Janet Juma for their patience and sincere guidance throughout this thesis. I would like to thank my entire family and everyone who made this thesis possible for their financial, and psychological support and patience while I was doing this thesis. Am also grateful to my Pastor Pst Raphael Enoch Yapha for encouraging me thought the process. It is not possible to mention everyone who was there for me but please accept my sincere appreciation. Thank you all.

ABSTRACT

The integration of information technology into nutrition care has emerged as a transformative approach to enhancing service quality, efficiency, and personalization, surpassing the limitations of traditional manual methods. Despite global progress in digitizing healthcare, Kenya's Food Exchange List (KFEL) was unautomated, posing challenges to effective meal planning. This study aimed to automate the KFEL for application in meal planning among nutritionists in Kenya. It led to the development of a meal planning application known as Diet Wizard. Diet Wizard guided the nutritionists step-by-step to input personal data of the patient, calculate nutritional needs, and generate customizable meal plans using a standardized food exchange system. Specific objectives included determining the metric measures of selected foods missing in the KFEL, developing a prototype application, and assessing its feasibility for use in clinical nutrition settings and analyzing the demographic characteristics of the nutritionists in Kenya. A cross-sectional study design was employed, targeting a population of 48 selected Kenyan foods and 297 nutritionists. Purposive sampling was used for the selected foods and random sampling for the nutritionists. Data collection involved laboratory-based food measurements, followed by an online app development and app feasibility survey using a structured online questionnaire. Due to limited digital access, 103 dietitians participated, and data were analyzed using SPSS Version 20 and Excel. The study analyzed 48 commonly consumed food samples to add onto the KFEL by determining their actual nutrient composition using laboratory measurements and standard values from the Kenyan Food Composition Tables. This information was incorporated into the Diet Wizard application data bank. Feasibility results indicated that the application significantly improved both the efficiency and accuracy of meal planning among nutrition professionals, with 73% reporting improved accuracy and 76.47% reporting reduced planning time. Usability was rated positively by 95.1% of respondents, and 87.3% expressed willingness to adopt the tool in professional practice. These findings highlight a strong need for digital innovations in nutrition care. Adopting Diet Wizard will help improve service delivery, save time, and enhance patient outcomes through efficient and modern nutrition care.

Key Words: Meal planning, Kenyan Food Exchange List, App development

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ABBREVIATIONS AND ACRONYMS

ADA	American Diabetes Association
BMI	Body Mass Index
BMR	Basal Metabolic Rate
BP	Blood Pressure
CSS	Cascading Style Sheet
EER	Estimated Energy Requirement
FEL	Food Exchange List
GSMA	Global System for Mobile Communication Association
HTML	Hypertext Markup Language
IDF	International Diabetes Federation
IOS	iPhone Operating System
KFEL	Kenya Food Exchange List
KHMS	Kenya Healthcare Market Survey
KNe-HS	National e-Health Strategy
WHO	World Health Organization
M-HEALTH	Mobile Health
MOH	Ministry of Health
NCP	Nutrition Care Plan
OS	Operating System
PAL	Physical Activity Level
NACOSTI	National Commission for Science Technology and Innovation

CHAPTER ONE: INTRODUCTION

1.0 Background of the study

Malnutrition is a burden and a frequent impediment for patients, especially those who are hospitalized. 50% of hospitalized patients worldwide are malnourished, and as of 2019, its incidence in Kenyan hospitalized patients was 30-76%v (Roberts et al., 2024). The length of hospital stays among malnourished patients proves to be significantly longer than in those who are well-nourished, with a p-value of 0.001 (Kariuki et al., 2019). Malnutrition affects the majority of patients during their hospital stays, and the risk is at 81.9% upon admission and 77.6% upon exit (Blaauw et al., 2019). Malnutrition raises the cost of care for hospitalized patients (Ministry of Health [MOH], 2018). In the recovery of patients from chronic diseases, wounds, infections, and surgical operations, nutrition treatment is just as important as medication. Their curative medical interventions are not as effective if their dietary status is inadequate or variable (Molnar et al., 2014). To prevent and treat malnutrition that rises during hospital stays, all patients need nutrition support. Nutrition support is defined as the provision of enough nutrients to maintain a healthy body weight and prevent undernutrition (Guinhut et al., 2020). Contrary to the conventional manual process of nutrition support, the use of information technology enhances the quality and effectiveness of nutrition support services in clinical settings (Skouroliahou et al., 2009). Apps and other digital technology provide more affordable, accurate and individualized nutrition advice. Individualizing nutrition guidance subsequently increases patients' adherence to healthy eating patterns (Fallaize et al., 2019). Nutritionists adhere to the Nutrition Care Process (NCP), a standard method for applying nutrition therapy, in order to promote evidence-based practice. They use a variety of tools as part of the process, with the Food Exchange List (FEL) being one of the tools used in various phases of the NCP (Brand et al., 2020). This FEL is a tool for meal planning that includes a list of items that are divided into

categories based on their average macronutrient and calorie contents. Each exchange list consists of products with comparable and nearly identical carbohydrate, protein, and fat values (Gillespie et al., 1998). Following a collaborative effort between the American Dietetic Association, The American Diabetic Association, and the US Public Health Service, the first edition of the food exchange list was released in 1950. Since then, there has been five updates, the second of which was made in 1976, the third in 1986, and the fourth in 1995 (Wheeler et al., 1996). The diabetic food exchange list had its most recent revision in 2008, with the name "choose your foods: exchange list for diabetes" (Geil, 2008). Researchers have examined food exchange lists globally and added their cultural delicacies unique to their cultural backgrounds (Bawadi & Al-Sahawneh, 2008; Coulibaly et al., 2009). Advanced research has also been done over the years on automated systems created to help with meal planning and the food exchange list. A system for automatically estimating the carbohydrates in traditional Thai meals was created in South Korea. In order to assist patients with type 1 diabetes mellitus and prevent the frustration of measuring their carbohydrate consumption (Chotwanvirat et al., 2021). Other applications include a carbohydrate counting app that use an image recognition system to identify photos in order to help those with inadequate nutrition and numeracy literacy (Alfonsi et al., 2020). In Qatar, a customized food exchange program known as "color coded tool" was created. This tool was created as an easy-to-use food exchange list to assist people in meal planning, especially those in low literacy groups (Bawdi et al., 2022). In Korea, a food exchange program called "Nutrisonic app" that included an automated electronic food exchange list was utilized to provide nutrition counseling (Hong et al., 2008). Studies over the years have identified the role of those new technologies play in communicating nutrition counseling and assisting dietitians to provide more individualized, cost-effective, and high-quality care services (Nyland & Lafferty, 2012). The (World Health Organization [WHO], 2011) recognizes the potential of mobile and wireless

technology to change how healthcare is provided globally in 2011. When combined with patient education and technical support, mobile health technologies play a significant role in the fight against the worldwide burden of chronic diseases (Guo et al., 2019). Studies claimed that nurses, doctors, dietitians, and other health professionals are increasingly using mHealth apps for e-prescribing, patient follow-up, patient data management, illness management, billing, medical references, and drug information (Sharman & Ashby, 2015). Nutritionists in particular, find that integrating mobile apps into their service delivery improves the quality and efficiency of nutrition care and counseling (Chen et al., 2018). Electronic health (ehealth) systems included mobile health (m-Health) applications. Robert Istepanian first coined the term "mHealth" in 2005 to describe the rapidly evolving mobile communications and network technologies in healthcare (Tucker., 2015).The development and application of mobile technology in the healthcare industry has increased having 325,000 mobile health apps available for download from the Google Play Store as of 2017 (Lau et al., 2020). Due to rising demand and the digitization of health services, there were 350,000 digital health apps available as of 2022 (Hasan & Bao, 2022).

Despite having a leading mobile phone penetration rate of 495 million subscribers, Africa still lags in adopting m-health (WHO., 2011).Sub-Saharan Africa accounts for 46% of this population (Global System for Mobile Associations [GSMA], 2021).Despite having an 88.1% smartphone penetration rate in 2016, the Kenya health sector market study (KHMS) found that Kenya is one of the African nations that still lags in the adoption of mHealth. In order to improve the health system and reach out to marginalized communities, Kenya launched its first national e-health strategy in 2011 (Gatero, 2011) .Due to the country's expanding use of communication and information technologies, mHealth programs have been recently being implemented in different government projects (Njoroge et al., 2017)

The stores for mobile platforms include; google Play, Apple App Store, Windows Phone Store, and Blackberry App. It was imperative to create a mobile app that would facilitate dietitians' work while preparing meal plans for their patients. This study sort to create an automated intervention that automates the usage of the Kenyan food exchange list known as “*Diet wizard*” for developing meal plan exchanges by dietitians to be used in personalized nutrition support and meal planning.

1.2 Problem statement

Since the early 1960s, researchers had tried to automate the challenging work of creating healthy and delectable menus and meal plans (Balintfy, 1964). There weren't many applications available to assist with menu planning (Lin et al., 2005; Yusof & Noah, 2017). Dietitians and nutritionists had found that calculating serving sizes for the manual meal planning process was a difficult task (Kovach, 1995; Yusof & Noah, 2017). Additionally, the manual use of the food exchange list, which served as the basis for menu planning and primarily used by dietitians and nutritionists in hospitals to determine portion sizes and exchanges, was a time-consuming and inefficient process. The traditional method of creating meal plans on paper and by hand had also shown to take a lot of time (Mustafa, et al., 2020). Nutritionists viewed meal planning as a time-consuming and difficult process since it involved several choice variables, as well as different limitations and objectives (Yusof & Noah, 2017). Even though there were apps that had automated the use of food exchange lists, the Kenyan food exchange list was still not automated, and nutritionists in Kenya were still using the manual method. This reduced the amount of time needed for educating patients and instead nutritionists spent a lot of time generating menus and diet plans. Due to the time-consuming procedure of calculating servings and distributing exchanges in the manual menu planning process, nutritionists frequently created menu or diet plans for specific

patients rather than all patients who required nutrition management (Samia et al., 2024). Little had been done in Kenya to automate the food exchange list or the menu planning process and to include the missing traditionally consumed Kenyan foods to help nutritionists with menu planning, despite the fact that other systems have been built to automate these processes (Gatero, 2011). Moreover, in Kenya, the current food exchange lists are limited and do not adequately capture the diverse range of locally consumed foods, especially traditional or indigenous foods. This inadequacy hinders nutritionists and dietitians from effectively planning meals that reflect the actual dietary patterns of different populations (Njoroge et al., 2017). Without precise metric measures such as gram weights and portion sizes of these foods, clinicians and nutrition software developers face challenges in providing accurate nutritional analysis and recommendations. There is a pressing need to identify and quantify these foods to ensure inclusive and culturally relevant dietary tools. A study demonstrated the importance of integrating localized food items into dietary applications to improve accuracy and applicability in diverse settings (Hong et al., 2008). Similarly, efforts in other regions, such as Iran, have shown that customizing food databases leads to better clinical outcomes and more user-centered nutrition care (Norouzi et al., 2018).

1.3 Purpose of the study

To develop a mobile health application that would act as a personal digital assistant to nutritionists by automating the usage of the Kenyan food exchange list in meal planning process.

1.4 Main objective

Design and Automation of the Kenyan food exchange list for meal planning among nutritionists in Kenya.

1.5 Specific objectives

1. To determine the metric measures of selected foods missing in the Kenyan food exchange list.
2. To develop a prototype application system that will automate the usage of the Kenyan food exchange list among the nutritionists in Kenya.
3. To determine the demographic characteristics of a sample of nutritionists in Kenya.
4. To assess the feasibility of the prototype application in meal planning among a sample of nutritionists in Kenya

1.6 Research questions

1. What are the metric measurements of selected foods that are missing from the Kenyan food exchange list?
2. How could a prototype application be developed to automate the use of the Kenyan food exchange list among nutritionists in Kenya?
3. What were the demographic characteristics of a sample of nutritionists in Kenya?
4. Is the prototype application feasible for meal planning among a sample of nutritionists in Kenya?

1.7 Justification

The food exchange list is one of the tools used to support the meal planning process (Franz et al., 1986 a). Utilizing food exchange lists helps in controlling diabetes, weight, cardiovascular risks, and promoting healthy eating (Jacqueline 2014). Health services and healthy lifestyles are

both improved by automating helpful health tools. The ability of automation technologies to personalize and individualize healthcare leads to their acceptance. Moving nutrition and lifestyle advice from a population level to an individual one through personalized nutrition will increase users' adherence to nutrition goals and help them change their behavior more successfully (Lim et al., 2022) Nutrition automation apps enable the provision of medical nutrition therapy and help patients better adhere to meal restrictions (Bawadi et al., 2022). There aren't many diet apps that help with meal planning, most diet apps are designed to support physical health and well-being (Vandelanotte et al., 2016). The KFEL has not yet been automated, and very little studies have been done to improve it. This research therefore aimed to develop an app that would automate the usage of the KFEL.

1.8 Limitations of the study

The application developed was limited to Kenyan foods, and as such, it may not be applicable for use with foods from other regions or international dietary guidelines. Additionally, the system was designed and tested specifically for use by nutritionists which limited its generalizability to other nutrition professionals or users outside Kenya. The study was further limited to participants who had access to a compatible device such as a smartphone, desktop, laptop, or iPad and a stable internet connection to interact with the web-based application.

1.9 Delimitations

This study was delimited to the perspectives and feedback of nutritionists, who were the primary intended users of the *Diet Wizard* application. The verification and evaluation of the system were conducted exclusively by these professionals, whose responses significantly contributed to the

development and success of the research. As such, the study did not incorporate views from other healthcare providers, nutritionists in non-clinical settings, or users outside Kenya.

1.10 Significance of the study

This study would add on the existing number of mHealth applications for nutritionists that had been developed worldwide and would be of great help in quick and quality preparation of meal plans which would improve client satisfaction and overall client services. The *Diet Wizard* would provide solutions to the problem of inaccuracies in use of the KFEL in meal planning also the problem of the process being time consuming and tiring. Furthermore, it would enable generation of a personalized meal plan prescription using the KFEL. The research evidence would also provide additional literature on the existing pool of knowledge in food, nutrition, dietetics and technology and give light to policy makers in Kenya in their process of policy making and development of guidelines, to include the updated evidence of the KFEL automation and evaluation. The application would help nutritionists in saving lives, especially for patients that require special diets. Nutritionists would also be able to use this research to improve patient care services in hospitals and communities by incorporating the usage of the *Diet Wizard* in meal planning.

1.11 Assumptions of the study

This study assumed that the participants would provide timely feedback through email and that the questionnaire used for data collection would yield reliable and valid responses. It was also assumed that the nutritionists who participated in the study responded honestly and accurately, based on their actual experience using the *Diet Wizard* application.

1.12 Operational definition of terms

Automation describes strategies or techniques in which numerous industrial activities are carried out automatically by robotic equipment or electronic gadgets.

Evaluation the laborious process of determining merit, worth, value, or usefulness is.

Kenyan food exchange list is a simple tool designed to help people establish healthy eating habits and adhere to a certain diet plan.

Diet planning is a key component of nutrition counseling, which enables patients to better control their weight and food related disorders including diabetes and renal disease by preparing meals ahead of time.

Mobile health (or "mHealth") refers to the use of wireless technology or portable devices by healthcare providers to facilitate communication between patients and healthcare providers, professional consultation, surveillance of patient health, and information retrieval for healthcare professionals at the point of care.

Metric measures refer to a decimal system of weights and measures based on kilograms and meters is referred to as.

Heuristic systems are mental shortcuts that aid in making quick, precise decisions and resolving problems.

Application is a program or piece of software which is made to serve a certain purpose.

A mobile application prototype is a program that serves as a mockup from which subsequent forms are created.

DIET WIZARD is an application that allows one to create a meal plan using an automated Kenyan food exchange list.

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

This chapter entailed the theoretical framework, critical review and conclusion. It explained the different studies that had been done in relation with the study's specific and the overall objectives.

2.1 Theoretical framework

2.1.1 Meal Planning Theory

Meal Planning Theory provides a conceptual framework for understanding how individuals and households make decisions about what, when, and how to eat. It explores the cognitive, social, economic, and cultural factors that influence meal choices and preparation. By examining underlying theories and models, this section aims to explain the processes, motivations, and constraints that guide meal planning behavior, offering insights into how people organize their food-related activities to meet nutritional, emotional, and social needs.

Economic Household Model

This approach originated from research that developed the work–leisure paradigm, using the household as the main unit of analysis. It proposed that households combined time and market goods to produce commodities that provided satisfaction. Time within the household was allocated among three main activities: working in the labor market, producing goods at home, and consuming. In relation to food, meal preparation and consumption required balancing these activities. Income earned from the labor market was used to purchase food ingredients, while additional time was dedicated to cooking and eating (Lewbel, 2015).

Random Utility Models

Random utility models took into account the decisions that consumers made when faced with independently exclusive discrete choices such as selecting between different brands. It was assumed that consumers wanted to maximize their utility, as shown by their choices. The utility function of a consumer was considered to be deterministic for that individual and, as a result, to have some components that were not visible to the researcher, such as taste preferences. Thus, the utility function could be divided into two parts; a deterministic component that was specified as a function of measured attributes of alternative products or individual characteristics, and a stochastic component that represented unobserved attributes that influence choice, interpersonal variations in utilities resulting from individual differences in tastes and measurement errors.

Food Choice Process Model

The Food Choice Process Model was created by Furst, Connors, Bisogni, Sobal, and Falk in 1996, and it stated that the life course, influences, and personal system were the three primary components of the model that explained how individuals make food choices. The life course included both the recent and recent past of eating. It made the case that in order to comprehend present patterns of food intake, it was important to comprehend trajectories, which were a person's enduring thoughts, feelings, tactics, and actions over the course of their lifetime. In particular situational and historical situations, trajectory development takes place. These persistent trajectory developments showed their own velocity and continuity. The family was regarded as the most significant social and historical environment, and as a result, a person's upbringing shaped their eating habits long after they had left their parents' house. Resources could be categorized as either material such as cash, machinery, and space or intangible such as culinary expertise, talents, and time. Both groups were thought to be significant determining

factors. The social framework captured the characteristics of social roles, interpersonal interactions, and meaning. The third element of the concept, the personal food system, was concerned with the mental processes by which people translated external factors into how and what they ate in a given situation. Value negotiations, which included weighing the relative advantages of many aspects, and strategies made up the two primary parts of this. The six key values that were considered while choosing food and making meal plans were quality, convenience, health/nutrition, and managing relationships (Furst et al., 1996).

Theory of Reasoned Action (TRA), theory of planned behavior (TPB)

The theory of reasoned action (TRA), created by Ajzen and Fishbein (1980), was based on the idea that a behavioral purpose was the best immediate predictor of conduct. The values of others and one's own attitude toward that action influenced one's behavioral intentions. When behavioral beliefs were paired with an assessment of the results of that activity, attitudes were formed (outcome evaluation). Subjective norms referred to the perceived social pressures that influenced individuals to perform or refrain from a particular behavior, often driven by the desire to conform to others' expectations. According to the Theory of Planned Behavior (TPB), three key factors shaped individuals' behavioral intentions: their attitude toward the behavior (personal evaluation of engaging in it), the subjective norms (perceived social pressure to perform it), and perceived behavioral control (the individual's belief in their ability or self-efficacy to execute the behavior).

2.1.2 Theory of Automation

Automation was made up of three basic parts: a power source for an activity, feedback controls, and machine programming. All of these traits were often shown by an automated system. Power

source; a system was developed to automate a useful task, and this process required electricity. Even though there were many available power sources, automated systems still mostly relied on electricity in modern society. Electrical power was the most versatile type of power since it could be easily generated from other sources and converted into other types of power to perform important tasks. Processing, transfer, and positioning were the two sorts of tasks that automated systems normally carried out. Energy was first used to process an object in the first situation. The procedure would involve the shaping or molding of materials like metal or plastic, the switching of electrical signals in a communication system, or the processing of data in a computerized information system. Each of these procedures used energy to transform the entity's current state or condition into one that is more favorable. In automated communications and information systems, the terms transfer and positioning referred to the movement of data between various processing units and the delivery of information to output terminals for human interpretation and application. Feedback controls were a common component of modern automated systems. An input, a controlled process, an output, sensor components, a controller, and actuation devices were the five basic components of a feedback control system. The set point, or reference value, for the system's output was determined by its input. This served as an example of the required operating value for the output. The variable being measured and compared to the input was the process' output. The measuring devices used in the feedback loop to monitor the value of the output variable were the sensing components. The controller and actuating components' roles in the feedback system were to contrast the measured output value with the reference input value and reduce the difference between the two. Machine programming was the process of determining the order of actions that was performed automatically by the system. The program specified the tasks that the automated system must carry out and how each component of it must operate in concert in order to produce the desired results. From one system

to the next, the program's content significantly varied. In fairly simple systems, the program consisted of a limited number of clearly defined operations that were executed repeatedly and continuously in the proper order with no modifications from one cycle to the next. In more complex systems, both the quantity of commands and the level of specificity in each command could be fairly large. The program enabled the order of events to be modified in increasingly complex systems in response to changes in raw materials or other operational variables. A specific programming command specified the set point for the feedback loop, which controlled the system's intended behavior. The basic goal of the feedback loop was to verify that the intended step was carried out. Programmable gadgets had the ability to make decisions while in use. The control program included the ability to make decisions in the form of logical instructions that govern how such a system behaved in a variety of circumstances. Under one set of circumstances, the system reacted one way, then reacted another way under another set of circumstances. For a variety of reasons, including error detection and recovery, safety monitoring, contact with people, and process optimization, granting an automated system decision-making authority was advantageous (Peter & Moravec, 2022)

2.2 Critical framework

2.2.1 History of food exchange lists

The Food Exchange List (FEL) was first created in the 1950s to cure conditions like diabetes and add diversity to people's diets. When the FEL was updated in 1976, the emphasis was placed more on increasing energy content and decreasing intake of fat and cholesterol. A subdivision of the milk category based on fat content was added to the exchange list revisions, along with non-fat, low-fat, and whole milk for the milk exchange group. The vegetable set featured every vegetable, with the exception of starchy vegetables, and each vegetable was specified as

providing 25 calories per 1/2 cup portion as part of the vegetable exchange. Starchy vegetables were included in the bread exchange category, whereas the meat exchange category included medium- and high-fat meats and items high in protein. The level of saturation is now displayed in the fat exchange group as either saturated or polyunsaturated fat (American Diabetes Association [ADA], 1994). The following iteration, which was completed in 1986, included a user-friendly list for meal planning and classified items into 6 categories based on their energy content. Inserting symbols into foods that are high in salt and fiber stressed the importance of reducing intake and boosting consumption. Franz and others, (1986 b) The 1986 food exchange list also included the nutrient value that was assigned to some exchanges. The food exchange list underwent yet another alteration in 1995 based on the American Diabetes Nutrition Recommendation of 1994. The major objectives of the revision included allowing for more flexibility in meal selections by grouping sources of carbohydrates into one unit. Expanding the food database list to include vegetarian, fast food, and fat-modified foods in order to enable for more accurate estimates of exchanges using nutrient information labels, recipes, and prepared dishes. The list's order and grouping underwent the most significant alteration in 1995. In a meal plan, items from the carbohydrate group included foods from the starch list, fruits list, milk list, and other carbs (Wheeler et al., 1996). The meat and meat substitute category were split into extremely lean, lean, medium fat, and high fat meats and meat alternatives, with no significant changes made to the vegetable group. To reduce overall fat, especially saturated fat, the fat group was separated into monounsaturated, polyunsaturated, and saturated fats (Holler ,1996). In 2003, the FEL underwent yet another redesign, this time reorganizing the food exchange list and clarifying and renaming the carbohydrate lists as sweet desserts and other carbs lists. The nutrient value, however, was the same between 1995 and 2003 (Daly et al., 2003). The diabetes exchange list had its fifth and most recent version in 2008, with the new title "select your foods: exchange

list for diabetes" (Wheeler et al., 2008). This tool was designed to help translate dietary advice based on scientific data into preferences for healthy eating (Geil, 2008). The food groups were reorganized in this edition, but the energy and macronutrient content per serving stayed the same. The starch and fat combination were moved from the starch list to other starch and labeled "additional fat" in the process. Dried fruits were included in the list of fruits, and a serving size of two tablespoons was considered one fruit. The milk group was expanded to include a new category of dairy-like foods. The meat and meat alternatives class also included plant-based cuisine. The non-starchy veggies as well as sweet sweets and other carbohydrates were spread out completely (ADA, 2008 a). The quick food list and grouping foods were divided into segments for ease of use, and the free food group was renamed to "Modified Fat Food with Carbohydrate." Additionally, a better alcohol menu was created, with choices measured against 100 kilocalories (ADA, 2008 b). Following the changes, due to the rise in health issues and the requirement for traditional diets to be included in the current food exchange lists, scientists created new exchange lists in accordance with their cultural location. The Malian trade list in 2009 was one example of a traditional food exchange in Africa. (Coulibaly et al., 2009). Greek exchange list (Trichopoulou et al., 2006), Jordan exchange list Kenya exchange list, and Nigerian food exchange list (Bawadi et al., 2009). The typical Pakistani chapatti (roti) had recently been included in Pakistan's food exchange list, which was previously problematic because of the different sizes of the chapatti and the fact that, although being the primary dish in Pakistani cuisine, it had not been included (Khan et al., 2015).

2.2.2 Use of food exchange list in Clinical nutrition practice.

Tools called food exchange lists contained lists of foods and drinks with almost comparable amounts of calories, carbs, proteins, and fats. Given that these foods and drinks had similar

nutritional properties, they could be exchanged within an exchange group (Marcus, 2013). Food exchange lists were used in meal planning as a tool that enables swapping of foods within a particular food group to give consumers flexibility and to enable greater adherence to the advised dietary regimen in relation to disease control. Research has demonstrated that FEL was effective in managing chronic, non-communicable diseases (Wheeler, 2008 b). Since its use ensured a balance and moderation of macronutrients which were crucial for weight control and lowered the risk of diabetes and cardiovascular disease the management of non-communicable diseases was achievable (Marcus, 2013). Because of this, nutritionists had primarily used the FELs to provide simple guidelines for their clients who sought to limit their macronutrient consumption (Lambert et al., 2001). Another study discovered that diets made from current and locally applicable FELs had the advantage of superior acceptance and increased odds of being applied successfully, helping to eliminate adherence-related issues such as a lack of options and erroneous portion sizes (Herselman & Esau, 2005). The KFEL was modified to contain traditionally acceptable foods and beverages of the Kenyan people so as to increase the chance of meal plans being realistic, acceptable, implemented and adhered to by patients following diet prescription by Kenyan nutritionists.

2.2.3 Software development life cycle

The term "software development lifecycle" referred to each stage in the development of a piece of software, from conception to deployment and maintenance. The Waterfall model was developed by Winston Royce in 1970 and was one of the models used in app development (Benington, 1983). The specification phase, design phase, implementation phase, testing phase, and maintenance phases are the separate development phases for this paradigm. According to this approach, one had to finish one phase before moving on to the next. The benefit of employing this model was that it did not require ongoing client collaboration or feedback, which made it

simpler for project managers to organize stakeholder communication. Because the goals were established from the beginning, it also had a predetermined timetable and budget. The biggest drawback of this technique was that it might be difficult and time-consuming to address unexpected problems while developing apps. Another model was the evolutionary model, which interleaved the steps of specification, development, and validation while providing prompt feedback. Here, a system's initial implementation was carried out and interactively improved in response to client feedback. The user had the opportunity to test out a partially created system, which reduced mistake because the essential model was well tested. The disadvantage is that it could be challenging to break the issue down into a number of customer acceptable iterations that could be given and realized incrementally.

The agile model was an approach that divided the entire process into interactions for incremental delivery. Another model was called a spiral model, and loops were used to represent specific phases of this process. Risk-related components were part of this methodology. Extreme programming was a variation on the incremental method, with its major features including pair programming, continual code refinement, client involvement, and delivery of extremely small functional increments. Native, web, hybrid, and progressive web application platforms were the four application platforms used in the creation of mobile applications. Platform for native applications, this platform mostly makes use of programming languages supported by certain platforms like OS, IOS, or Android. Web apps are designed to be accessed using an internet browser and do not require downloading or installation. Using HTML5, CSS, and Java Script, web apps are created. Web and native application components are both included in a hybrid application platform. The development of hybrid apps required additional technological expertise (Nunkesser & Robin 2018). In this architecture, a progressive web application was made up of a specific software program that worked on several operating systems (android, iOS,

and Windows phones), efficiently used the device memory, and was available even without an internet connection. The limitations of hybrid, Android, and web-based application architecture for mobile devices were solved by this web application (Khan et al., 2019).

2.2.4 Recommendation app architecture

Each program had two main levels, two layers; the IU layer, which showed the program on the screen, and the data layer, which housed the app's business logic and exposed application data. To streamline and reuse the interactions between the UI and Data layers, a third layer known as the domain layer was added.

2.2.5 Recommender system

Beginning with an automatic BMI calculation, the Diet Wizard suggested whether the patient is normal, obese, or underweight. Such selections were made using straightforward rules. The energy needs of each individual patient could be determined automatically using this way. Based on factors such as activity level, stress level, and basal metabolic rate, a predictive equation was utilized to estimate energy needs. The predictive Harris-Benedict equations (Long et al., 1979) equations used to compute the Basal Metabolic Rate (BMR) were multiplied with the level of physical activity to determine the Estimated Energy Requirement (EER) (PAL) 1989 National Research Council. Based on a user's energy expenditure, age, sex, weight, and height, their BMR is computed. Energy need = BMR x stress factor is the formula employed. The quick method formula, which read "Energy need = weight (kg) quick method factor," was used in method two. Following the creation of the food exchange table by food groups. After reviewing it, the clinical nutritionist will ask for the final exchange table by meal. A customized meal based on traditional Kenyan dishes would then be generated by the nutritionist.

Example of meal plan generation by manual method

Table 2. 1

Food Exchange Distribution by Food Group

Food	Exchanges	Carbohydrate (g)	Proteins (g)	Fats (g)	Energy (kcal)
Milks	3	45	24	24	480
Vegetables	5	25	10	-	125
Fruits	4	60	-	-	240
Starches	12	180	36	12	960
Proteins	6	-	42	12	276
Fats	3	-	-	15	45
Sugars	5	-	-	-	100
Total	0	310	115	115	2226

Table 2.2

Meal exchange distribution

Food exchange	No of exchanges	Breakfast	10 O'clock	Lunch	4 O'clock	Dinner
Milk	3	2	1	0	0	0

Non starchy vegetable	5	1	0	2	0	2
Fruits	4	1	1	1	1	0
Starches	12	3	2	3	2	2
Proteins	6	2	0	2	0	2
Fats and oils	3	1	0	1	0	1
Sugars and sweets	5	2	2	0	1	0

Table 2. 3

Sample meal plan

meal type	milk	non-starchy vegetables	fruits	starches	proteins	fats and oils	sweet and sugars
breakfast	2 cups whole milk	1 tomato	1 small banana	3 slices brown bread	2 eggs	1 tsp oil	1 tsp sugar
morning snack	3/4 cup yoghurt 10.00		2 tbp raisins	6tbsp granola			2 tsp sugar
lunch		1 cup cooked spinach	1 small orange	1 cup ugali	2 palm fish	1 tsp oil	

evening snack		1 lime	1 cup porridge		1 tbsp. sugar
dinner	1 cup steamed cabbage		1 cup cooked rice	1 cup cooked green grams	1 tsp oil

2.3 Related work

2.3.1 Automated food exchange lists

Researchers with the primary goal of assisting nutritionists in meal planning for diabetes patients, specifically to enable the suggestion of snacks for diabetic patients, automated the Iranian food exchange list. This mobile application system was focused on creating meals based on the patient's interest and body mass index because three meals a day were the usual eating schedule in Iran. When tested for viability by three nutrition experts, its accuracy was very high (75 to 100%) and ranged from 50% to 74%. However, this approach could not be relied upon to prepare a thorough meal plan for a patient with type 2 diabetes because it only contained snacks and left out the main meals (Norouzi et al., 2018). However, the Diet Wizard contained all foods rather than just snacks, and nutritionists could rely on it to create a complete diet plan. An online program called Nutri Sonic web expert was developed in Korea that included the use of an automated electronic food exchange list to help with meal planning. Its key features included

meal management, menu management, food management, search, and a food exchange analysis. It was created for use by nutritionists and dietitians in the process of meal planning to control type 2 diabetes, obesity, and other conditions that call for diet therapy. The user had to use the internet to acquire the material, which only comprised information on the Korean diet, despite the web expert's protests. The application system gave professionals access to the essential data and enabled them search, add, change, and delete it. Additionally, the meal plan could be downloaded by the expert as an excel file for analysis or statistics after meal preparation (Hong et al., 2008). Nutritionists were able to access this suggested system offline while creating meal plans, making it a less expensive option. The user would only need to utilize data to install the application. The app also featured traditional Kenyan meals, which would help dieticians concentrate on developing practical meal plans and improving patient adherence to them. Furthermore, unlike the Nutrisonic web expert system, the Diet Wizard would let dieticians build meal plans for individuals with a variety of diseases rather than only diabetes. An application called "DIET" was created by with the goal of reducing errors in data recording, calculating daily requirements for each patient, creating daily menus for all patients, storing patient data in records, and producing reports on previous food lists and menu costs. The software in this system determined the daily nutritional needs and generated the patient's daily menu. The patient's dietetic prescription or medical condition did not forbid any of the meals on the menu that had been noted as intolerances, allergies, dislikes, or foods that the patient is intolerant to (Skouroliahou et al., 2009). In 2020, a program called iDietScore, which automates the food exchange list, was created for use in nutrition counseling by sports dietitians/nutritionists. It was created as a result of an increase in the demand for meal plans from a large number of athletes, which the manual meal planning procedure could not handle. The software gave the user the option to design a digitally unique meal plan. The program achieved this by automatically

computing the necessary macronutrients and calories, which were then utilized to generate the meal plan, meal allocation by time, and food exchange distribution table. Based on a person's energy needs, macronutrient requirements, sport category, age group, training cycles, training time, and personal dietary preferences, the meal plan was tailored for them (Mustafa et al., 2020). This smartphone app could not be relevant in hospital circumstances or for meal plan recommendations and was only relevant to an athlete or an active person. The Diet Wizard could be used by nutritionists to increase patient coverage in terms of meal plan generation and it would help in reducing their burden in meal plan development. The creation of the MyFelo application, which automated the Malaysian food exchange list, was the result of additional study. To create the app, the study used case-based reasoning combined with an ontological approach. The software was created using pre-existing ontologies like cooking and nutritional food, where cooking ontology was tied to prepared food and nutritional food was related to meal planning. The dietician entered patient information into this program, including BMI, religion, and race. Based on how closely the indexed properties of the new case and the old case matched up, the algorithm then got the best-case basis. The system then confirmed that the meal planning was within the calorie range by examining the portion size of food products. The adaptation engine suggested a new food to make up the difference in serving size if the serving size was less than the needed value. A patient-specific meal plan was the product's final form. This program, called MyFelo, included individualized elements like race and religion. Additionally, it addressed the portions of both raw and cooked foods. The study sought to reduce the difficulty of creating nutritional meal and menu planning (Moursi et al., 2021). Nutritionists could create menus for hospitalized patients using an application called Diet Pal, which was created to automate the usage of the Malaysian food exchange list. The anthropometric data was first entered by the dietitian or clinical nutritionist before the system could calculate the BMI automatically. The

patient was then labeled as underweight, overweight, or obese. The machine then produced the energy the patient needs. The clinical nutritionist chose the available foods from the food exchange database after speaking with the patient. Then, depending on BMR, physical activity, and stress factor, Diet Pal automatically determined the level of macronutrients with specific calorie requirements. The system directed the user to the following phase, where an automatically generated exchange table of food groups was generated. The nutritionist was next required to complete the exchange table portions for the appropriate meal time once this exchange table by food groups had been created. Create the exchange table for food groups afterwards. The nutritionist could save the data by using comparable methods that are stored in the program for later usage (Hattab et al., 2022a).

2.3.2 Analysis of foods to add to an existing standard food exchange list

A study conducted in Nigeria led to an assessment of the native foods there with the intention of fostering local food exchange there. In the study, 100 g of raw food samples were cooked according to a standard recipe to generate cooked weights. The cooked food samples were weighed using a kitchen scale and a standard home food measure to produce 15 g of carbohydrates, 7 g of protein, and 5 g of fat., this was done for the purposes of enriching the Nigerian food exchange list (Fadupin, 2009a). In a different Jamaican study, a list of Jamaican cuisine was compiled by professional chefs of Caribbean descent. The dishes were then prepared at the food science laboratory. The purpose of the study was to create a dietary exchange system and assess the macronutrient and energy composition of Jamaican cuisine. After purchasing the products from a neighborhood Caribbean market, undergraduate dietetic students had them individually evaluated for their nutritious content. The standard energy value of food was used to calculate the total calories in each macronutrient category using their smart precision pro

multipurpose digital kitchen scale. The study recommended more study of the elements of a culturally appropriate diet, particularly the food exchange list (Goldschmidt et al., 2018). Another evaluation study, utilizing household measurements of the amount of dry wheat flour used in accordance with the chapatti size, was carried out in Pakistan. The study's primary goal was to make the various chapatti roti sizes available for inclusion in the current Pakistan exchange list.

Every Pakistani dish started with chapatti, which had not yet been regulated or included to Pakistan's list of acceptable foods. According to the study's findings, a single small chapatti provided 37.5 g of carbohydrates, which were then turned into 2.5 carbohydrate exchanges. Medium chapattis in the evaluation trial weighed 56.25 grams of carbs, while large chapattis weighed 75 grams. Then, it was divided into four and five different carbohydrate swaps, respectively. A caliper was used to estimate the chapatti's thickness, and a ruler was used to measure the chapatti's diameter to calculate its size. According to the study, a large chapatti with a diameter of 4 1/2 inches and a weight of 120 grams contains 75 grams and 5 exchanges. The study suggested more research be done on traditional foods (Khan et al., 2015). In this study, various selected foods from Kenya were examined in a lab setting to be able to add to the automated KFEL app database.

2.3.3 Feasibility studies

The feasibility of a mobile application for personalized nutrition tracking known as Good Measures (GM) was studied in West Virginia in 7 clinics across the state, with 14 healthcare professionals and 64 patients enrolled. Over the years, feasibility studies of mobile applications have been conducted. By using a smartphone, tablet, or computer to document their meals and exercise, this program enabled patients to interact virtually with a qualified dietitian or clinical

nutritionist for an entire session. The utilization of the application and feedback inquiries regarding its advantages and drawbacks were used to conduct the feasibility program. The study found that it was possible for all populations to apply an e- and m-health application approach to healthcare, nutrition, and lifestyle (Olfert et al., 2019). Another study was done to determine the acceptability and viability of a self-regulation app that would guide users toward a healthy lifestyle by using a variety of self-regulation approaches. After using the app for two weeks, semi-structured interviews with 20 adults were conducted. The results showed that my day plan was well welcomed, and it was advised that conducting a feasibility study before creating an e and m health intervention was crucial. Many users 14 out of 20 users thought the app was user-friendly. 17 out of 20 users praised the application's time efficiency, whereas 3 out of 20 reported technical issues when using it and 5 out of 20 reported using it with difficulty (Degroote et al., 2020) .Further study resulted in the creation of a computerized food exchange list that allowed for the geriatric population's nutritional planning. The study revealed that the meal exchange list was generated by the automated algorithm in just 2–10 seconds. The study also showed that using the food exchange list manually led to a lot of inconsistencies when constructing diet lists, and that using a human force can take more time through trial and error before the right solution is discovered (Dholvitayakhun & Kluabwang, 2014).In a different study, a program to help obese kids cut back on their eating and track their physical activity was developed. After a four-week feasibility study in which their eating habits and treatment were evaluated, the program's viability was rated at 40% among kids and teenagers who qualified (Browne et al., 2020).In a study done in 2017, also evaluated the viability of a mobile application called Manager 2. 54 patients over the age of 40 participated in the trial, and the application was used to record daily food intake for at least three days. After that, a dietician examined the app's data. This study demonstrated that the Manager App was a practical substitute for keeping a manual food diary

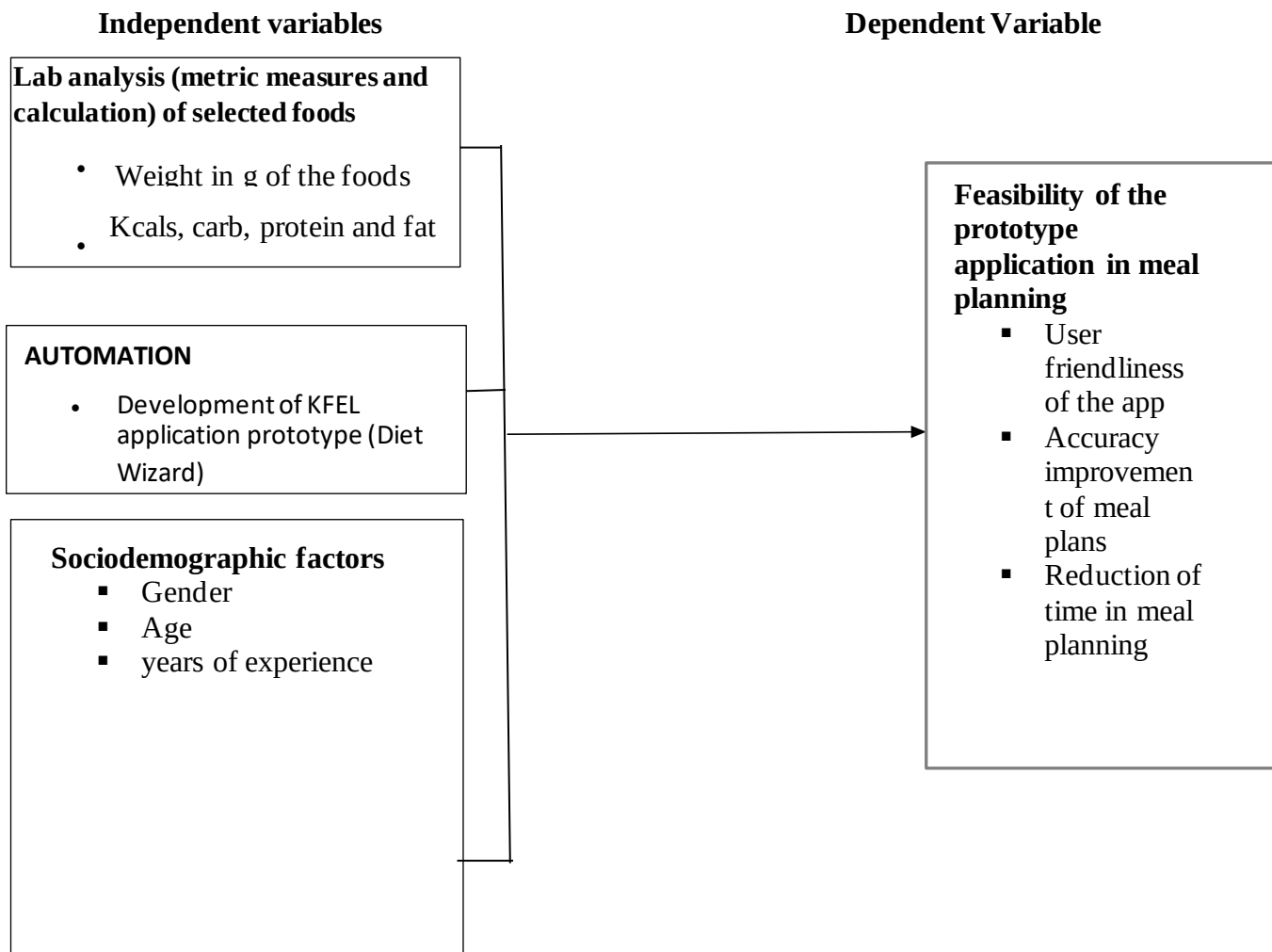
(Ali et al., 2017). A pilot study was conducted in a hemodialysis unit in the Gassmi hospital to test the viability of the KE LA app, which was the subject of another feasibility study. Patients who attended once per week were given dietary treatments by dietitians, and results were assessed two weeks after application use. The app had the ability to boost food intakes and it was demonstrated to be practical (Khoury et al., 2020). A study was also conducted to examine the viability and efficacy of dietitians' own application for weight reduction counseling with patients who were overweight or obese. The study, which took place in Switzerland and involved participants receiving therapy via an app and communicating with a nutritionist, focused on regular phone calls for feedback, food log incentive, and education (Chen et al., 2018). The application showed substantial changes in users' waist circumference, body fat, blood pressure, and eating habits over the course of a year of study. Professional dietitians said the app was helpful and offered efficient support for long-lasting weight loss. Following this, the application developed in this research would be used by several nutritionists to construct meal plans, and its viability would be assessed by measuring the time required for the process and comparing it to the time required for the manual method. The involved dieticians would also be questioned about how simple or difficult the application was to use.

2.3.4 Conceptual framework

The figure below shows the conceptual framework of the research that will lead to the achievement of the study objectives.

Figure 2. 1

Conceptual framework



CHAPTER THREE: METHODOLOGY/METHODS AND MATERIALS

3.0 Introduction

Research methodology, according to Patel and Patel (2019), is the study of how scientific research was conducted. It was defined as the various steps a researcher takes to look into their research issue, as well as the reasoning behind them. The research design, target population, study protocol, instrumentation, data collection methods, data analysis, and ethical consideration is all included in this section to clarify how the investigation would be conducted.

3.1 Research design

In research investigations, the methods used for data collection, analysis, interpretation, and reporting are collectively referred to as research design (Boru, 2018). This research employed cross sectional study design to achieve the overall objective of the research.

3.2 Study location

Study location refers to the specific geographical area or setting where a research study is conducted. It identifies the physical or contextual environment in which data are collected, such as a country, region, institution, or community, and provides background information to help understand the relevance and applicability of the study findings (Boru, 2018). This study was conducted in Kenya

3.2 Target population

The target population, according to this research is the group of people who are involved in the research and development of the intervention's findings (Barnsbee et al., 2018). The study population comprised 48 locally available and commonly consumed foods representing different

food groups in Kenya. These included cereals (biscuit, pancake, wheat flour, mandazi, millet, cassava meal), legumes (cowpeas, green grams, lentils, chickpeas), vegetables (spinach, kales, cabbage, amaranth, okra, nightshade, pumpkin leaves), and fruits (pineapple, watermelon, papaya, mango, guava, lemon, dates). Fats and oils such as corn oil, lard, ghee, and honey were included, alongside nuts and seeds like peanuts, cashew nuts, macadamia nuts, sesame, sunflower, and pumpkin seeds. Goat milk was also analyzed to provide a comprehensive representation of locally consumed foods. In the app feasibility investigation, the study's target population comprised nutritionists working in Kenya, representing professionals actively engaged in nutrition planning, counseling, and service delivery across various health and institutional settings.

3.3 Sampling procedure

Purposive sampling was used in this study to selected cultural foods that are not present in the KFEL data, Then the app prototype was developed using the KFEL data and the additional foods measured, a digital questionnaire was then used to collected data from various regions of Kenya. The research also chose samples of nutritionists by systematic random sampling. After which the nutritionists answered the questionnaire and submitted it via email.

3.4 Sample size

According to data from the Kenya National Bureau of Statistics as of 2019, there were 3,066 nutritionists and dieticians, 4,430 nutrition and dietetic technologists, and 813 nutrition and dietetic technicians, whereas information from the Ministry of Health showed that there were approximately 1,300 nutritionists employed by the government to serve the entire nation (KNBS,

2022; MOH, 2017) Therefore, to determine the sample size for the study, 1300 nutritionists was used as the total population in this study.

Calculation of sample size according to (Krejcie & Morgan, 1970)

$$\text{Sample size} = \frac{X^2 NP(1-P)}{d^2(N-1) + X^2 P(1-P)}$$

Where;

X^2 – Is chi square value corresponding to 95% confidence interval (3.8416)

N – Represents the given population size (1300) P - Is the population proportion (0.50) d - Refers to the margin of error or degree of accuracy (0.05) at 95% confidence interval

$P=0.5$ was used to maximize variability.

Therefore, $P(1-P)$

$$= 0.50 \times 0.50 = 0.25.$$

Based on population size,

$$X^2 \times N \times P(1-P) = 3.8416 \times 1300 \times 0.25 = 1248.52.$$

$$D^2 = 0.05^2 = 0.0025.$$

Therefore, the adjusted population size = $D^2 \times (N-1)$

$$= 0.0025 \times 1299 = 3.2475.$$

sample proportion at the given confidence level = $X^2 \times P(1-P)$

$$= 3.8416 \times 0.25 = 0.9604.$$

To find the denominator $=3.2475+0.9604=4.2079$

The estimated sample size $=1248.52 \div 4.2079=296.7$

=297 nutritionists.

3.5 Inclusion criteria

These were the crucial elements of the target population that the researchers used to respond to their inquiry (Patino et al., 2018). The most often employed components of inclusion criteria were those related to demographic, clinical, and geographical characteristics. Only employed Kenyan nutritionists were included in this study and for the lab analysis, only the selected food samples were analyzed and recorded.

3.6 Instrumentation

This was a procedure for gathering data that entailed instruments or methods used by researchers to evaluate variables or other things of interest (Salkind, 2010). A table of food items was generated which was to be used for data collection during the analysis of the food samples. An app prototype was then developed after which, data from the nutritionists' sample was gathered using a multi-structured automated questionnaire that was created for the purpose. An eight-step flow diagram was drawn to be used in inputting data and to guide in the calculations required in the data programming in order to come up with the Diet Wizard application.

3.7 Methods of data collection

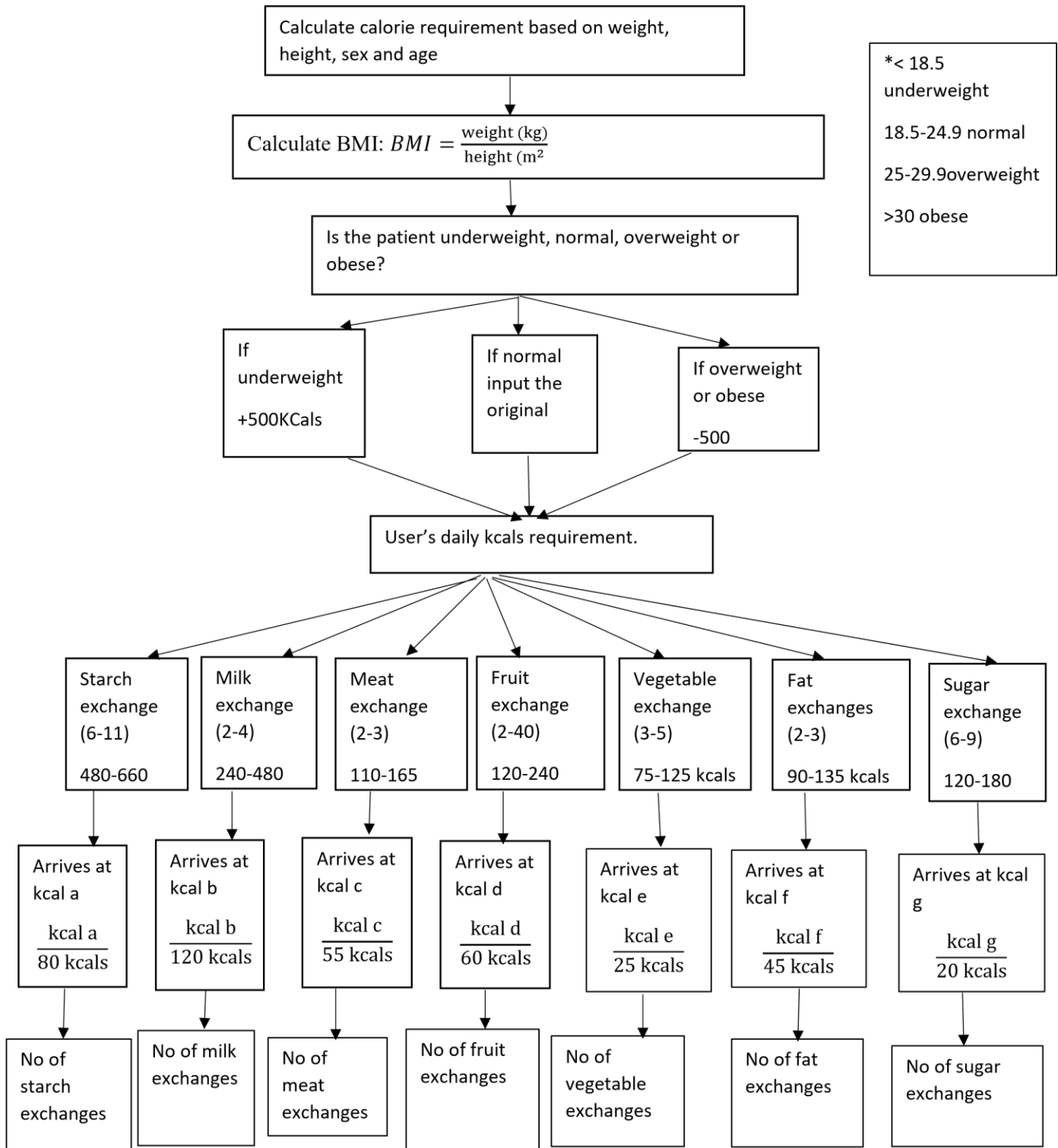
Data collection is defined as the process of gathering and analyzing information on relevant variables in a systematic way so that researchers would respond to research questions, test hypotheses, and evaluate results (Kabir, 2016). Foods that were used in the lab test were

purchased in accordance with the identified selected sample. First, representative food samples were identified based on their popularity and frequency of consumption in various regions. A total of 48 food samples were selected, encompassing different food groups such as starches, milk, vegetables, fruits, fats and oils, and sugars. The actual edible portions of each food were weighed using a calibrated electronic weighing scale, and their average mass in grams was recorded to represent commonly consumed portion sizes. Nutrient values specifically energy (Kcals), protein (PRO), fat (FAT), and carbohydrates (CHO) were calculated using standard reference data obtained from the Kenyan Food Composition Tables (Mwai et al, 2018). For each food item, the nutrient content per 100 grams (as given in the composition tables) was multiplied by the actual measured portion weight (in grams) and then divided by 100 to obtain nutrient values per edible portion. This calculation ensured that the nutritional estimates accurately reflected locally consumed portion sizes rather than standardized laboratory weights. The calculated values were then averaged for each sample and summarized in Table 4, presenting the mean energy and macronutrient composition of the foods. These results were further standardized in Table 5 to align with food exchange categories used in diet planning. Foods were adjusted to fit within the energy ranges commonly applied in the Kenyan Food Exchange System, such as 80 Kcals for starches, 25 Kcals for vegetables, 60 Kcals for fruits, 45 Kcals for fats and oils, and 150 Kcals for milk. The household portions and metric measurements in grammage were determined, afterward standard data values from the Kenyan food composition table were sort and were used to calculate the Kcals, protein, carbohydrates and fat values of the food samples analyzed. This information together with the information in the Kenyan food exchange list was used in the development of the mobile application. The development of the system prototype (Diet Wizard) application was guided by a step-by-step flow diagram. An internal calculation in the system first determined the patient's calorie needs. The patient was

then classified as underweight, normal, overweight, or obese based on their BMI by the system. If the patient was underweight, the system automatically added 500 kcals to the calories received; if the patient was normal weight, it displayed the original value; and if the patient was overweight or obese, it subtracted 500 kcals from the calories received. The adjustment of plus or minus 500 kilocalories was based on the general principle that a daily energy deficit or surplus of approximately 500 kcal leads to a body weight change of about 0.45 kg per week (Heart et al., 1998). This guideline is widely used in clinical nutrition and dietary planning to achieve gradual and sustainable weight modification. Therefore, adding 500 kcal supported weight gain in underweight individuals, maintaining the original energy value ensured stability in those with normal weight, and subtracting 500 kcal promoted moderate weight loss among overweight or obese individuals. Then it generated food exchanges automatically. For starch, the system calculated exchanges and shuffled within the range of 6-11 servings, which is 480-660 kcals. For milk, it did the same within the range of 2-4 servings, which was 240-480 kcals. Finally, it generates food exchanges within the range of 2-3 servings, which was 110-165 kcals. The fruit exchange shuffled the users' calorie counts between a range of 120 and 240 kcals using a range of 2-4 servings. In the vegetable exchange the system used a range of 3-5 servings to find the calorie value range of 75-125 moreover in the fat exchange the system used 2-3 servings to calculate a range of 90-135 kcals, and in the sugar exchange the system employed 6-9 servings to calculate a range of 120-180 kcals. Afterwards, the system automatically picked a value from the range that was in line with the user's values and provide the exchanges to use for starch, milk, meat, fruit, vegetable fat and sugar exchanges. A close-open ended questionnaire was used to collect data from the Kenyan nutritionists for responses on the feasibility of the application developed.

Figure 3.1

Flow diagram of the Diet Wizard derivation of exchanges



3.8 Validity and reliability of instruments

To ensure the accuracy and consistency of the data collection tool, the questionnaire was developed and validated by Mitch Anyul working at Alpha-HB Consultancy a statistician with expertise in data analysis and research methodology with BSc. Economics and Statistics from Egerton University. The validity of the instrument was determined through expert judgment, where the statistician assessed the content to ensure that all items were clear, relevant, and also ensured that the stated questions would lead to the achievement of the research objectives.

3.9 Proposed method of data analysis

Data was analyzed using the Statistical Package for Social Sciences (SPSS) version 20.

3.10 Data presentation

Data was presented with the use of pie charts, graphs, percentages and measures of central tendency (median, mode and mean).

3.11 Ethical consideration

Ethical approval to carry out the study was sought from Kenya Methodist University research committee. The National Commission for Science, Technology and Innovation (NACOSTI), permit was sought. Consent forms are given to dietitians who are sampled for the study to write. Every respondent was assured non-disclosure of the information shared and they were made aware of their freedom to participate or withdraw.

CHAPTER FOUR: RESULTS AND FINDINGS

4.0 INTRODUCTION

This chapter contains results and findings that will serve as a source of insight for the study and inform various recommendations. The chapter provides results and findings for each of the variables under consideration. The research data analysis was done using SPSS and Microsoft Excel. It provides both theoretical and visual explanations and responses to answer the research questions.

4.1 Laboratory Analysis of Selected Kenyan Foods for Inclusion into the *Diet Wizard* app data base

This table 4 presents laboratory findings of selected food samples, where actual weights of commonly consumed portions were measured in grams and used to calculate their nutritional values. The study used 48 samples of selected foods which were commonly consumed locally but were not included in the Kenyan Food Exchange List. The calculations were performed using standard values from the Kenyan Food Composition Tables, which provided energy (kcal), protein, fat, and carbohydrate content per 100 grams. These standard values were applied to the measured portion sizes obtained from the laboratory to estimate the actual nutrient content of each food as typically consumed.

Table 4.1

Nutritional values (Kcals, Proteins, Fats and Carbohydrates) of selected measurements of commonly consumed foods in Kenya using standard values from the Kenyan food composition tables.

food sample	sample size	AVERAGE MASS (g) of sample	Kcals of sample	PRO of sample	FAT Of sample	CHO Of sample
-------------	-------------	----------------------------	-----------------	---------------	---------------	---------------

Biscuit	1 piece (2 1/2 inches)	5	24.6	0.3	0.2	2.9
Pancake	1/2 medium size	28	75.6	2.3	2.4	11
Wheat flour	1/2 medium size	36	122.4	2.7	5.8	17.6
Mandazi	1/3 cup	125	187.5	2.4	0.9	40.1
Millet (ugali)	1/3 cup	103	119.5	2.2	0.8	24.1
Cassava meal (ugali)	1/2 cup	100	71	5.7	0.3	9.8
cooked Cow pea	1/2 cup	126	44.1	5	0.9	2.6
Cooked pumpkin	1/2 cup	100	116	10.1	0.6	14.3
Green grams	1/2 cup	100	120	10.1	0.2	15.6
Cooked lentils	1/2 cup	100	323	22.3	5.1	34.3
Cooked chick pea	1/2 cup	138	66.2	2.2	0.1	12.1
Cooked butternut	1/2 cob	116	128.8	3	1.7	23.8
Corn boiled maize cob	1/2 cup	148	174.6	3	0.3	36.9
Yams	250ml	255	234.6	10.5	13.5	17.3
Goat milk	1/2 cup	100	28	2.5	3.2	2.1
Cooked spinach	1/2 cup	100	28	2.9	0.3	1.2
Cooked kales	1/2 cup	75	20.3	1	0.2	2.4
Cooked cabbage	1/2 cup	75	28.5	2.9	0.2	1
Cooked amaranth leaves	1/2 cup	76	24.3	1.5	0.2	2.7
Cooked okra						

Cooked cauliflower	1/2 cup	51	9.7	1	0.1	0.5
Cooked Jute mallow (mrenda)	1/2 cup	100	45	4.6	0.2	2.1
Cooked cucumber	1/2 cup	100	11	0.6	0.1	1.3
Cooked nightshade (managu)	1/2 cup	50	15.5	1.9	0.1	0.7
Cooked spider plant (saga)	1/2 cup	101	43.4	4.8	0.8	2.1
Cooked Pumpkin leaves	1/2 cup	125	73.8	4.3	2.9	6.8
Pineapples	1 cup	126	51.7	0.6	0.3	10.2
Watermelon	1 cup	100	26	0.6	0.3	5
Papaya	1 cup	126	45.4	0.8	0.4	8.6
Guava	1 medium size	100	48	1.3	1.1	0.9
Passion fruit	1 piece	100	35	2.4	0.9	8.9
Lime	1 small	75	31.5	0.5	0.2	4.7
Lemon	1 medium size	100	47	0.6	0.7	9.5
Mango	1 medium size	104	66.6	0.6	0.3	14.6
Tree tomato	1 fruit	25	10.8	0.5	0.1	3.5
Dates	5 dates	42	63.8	0.7	0	14.8
Corn oil	1 tsp	5	45	0	5	0
Lard	1 tsp	9	80.1	0	8.9	0
Ghee	1 tsp	9	80.8	0	9	0
Cashew nuts	1/3 cup	36	214.2	2.1	5.9	17.3
Roasted Peanuts	¼ cup	30	177.9	1.8	6	14.5
Macadamia	1/3 cup	30	208.8	2	21.3	0.6

nuts						
Bambara	1/3 cup	32	102.7	5.8	1.9	11.1
nuts						
Sunflower	3 tbsp	32	190.4	5.9	16	4.7
seeds						
Sesame	3 tbsp	32	192.6	4.9	17.3	2
seeds						
Amaranth	¼ cup	30	36.3	1.5	0.6	6
seeds						
Watermelon	¼ cup	34	200.6	10.2	16.2	2.6
seeds						
Pumpkin	3 tbsp	32	184	7.8	15.2	3.1
seeds						
Honey	1 tsp	8	25.8	0	0	6.4

Source of standard values (Food Composition Government Of Kenya)

by (Mwai et al, 2018)

Table 4. 2

Suggested foods for incorporation into the food exchange list per category

FOOD GROUP	Food sample	AMOUNT(g)	PRO	FAT	CHO	Kcals
STARCH	Biscuit	16.3	1.0	0.7	0.7	80kcal
	Pancake	29.6	2.4	2.5	11.6	80kcal
	Wheat flour					
	Mandazi	23.5	1.8	3.8	11.5	80 Kcals
	Millet (ugali)	53.3	1.1	0.4	17.1	80 Kcals
	Cassava meal(UGALI)	69.2	1.5	0.5	16.2	80 Kcals
	cooked					
	Cow pea	112.7	6.4	0.3	11.0	80 Kcals
	Cooked	228.6	9.1	1.6	4.7	80 Kcals
	pumpkin					
	Green	69.0	7.0	0.4		80 Kcals

	grams					
	Cooked					
	lentils	66.7	6.7	0.1	10.4	80 Kcals
	Cooked					
	chick pea	24.8	5.5	0.3	8.5	80 Kcals
	Cooked					
	butternut	166.8	2.7	0.1	14.6	80 Kcals
	Corn boiled					
	maize cob	72.0	1.9	1.1	14.8	80 Kcals
	Yams	67.8	1.4	0.1	16.9	80 Kcals
MILK	Goat milk	163.0	6.7	8.6	11.1	150Kcals
VEGETABLES	Cooked					
	spinach	89.3	2.2	2.9	1.9	25 Kcals
	Cooked					
	kales	89.3	2.6	0.3	1.1	25 Kcals
	Cooked	92.4	1.2	0.2	3.0	25 Kcals
	cabbage					
	Cooked					
	amaranth	65.8	2.5	0.2	0.9	25 Kcals
	leaves					
	Cooked					
	okra	78.2	1.5	0.2	2.8	25 Kcals
	Cooked					
	cauliflower	131.4	2.6	0.3	1.3	25 Kcals
	Cooked					
	Jute mallow	55.6	2.6	0.1	1.2	25 Kcals
	(mrenda)					
	Cooked					
	cucumber	227.3	1.4	0.2	3.0	25 Kcals
	Cooked					
	nightshade	80.6	3.1	0.2	1.1	25 Kcals
	(managu)					
	Cooked					
	spider plant	58.2	2.8	0.5	1.2	25 Kcals
	(saga)					
	Cooked					
	Pumpkin	42.3	1.5	1.0	2.3	25 Kcals
	leaves					
FRUITS	Pineapples	146.2	0.7	0.3	11.8	60 Kcals
	Watermelon	230.8	1.4	0.7	11.5	60 Kcals
	Papaya	166.5	1.1	0.5	11.4	60 Kcals
	Guava	125.0	1.6	1.4	1.1	60 Kcals
	Passion fruit	171.4	4.1	1.5	15.3	60 Kcals
	Lime	142.9	1.0	0.4	9.0	60 Kcals

FATS AND OILS	Lemon	127.7	0.8	0.9	12.1	60 Kcals
	Mango	93.7	0.5	0.3	13.2	60 Kcals
	Tree tomato	138.9	2.8	0.6	19.4	60 Kcals
	Dates	39.5	0.7	0.0	13.9	60 Kcals
	Corn oil	5.0	0.0	5.0	0.0	45 Kcals
	Lard	5.1	0.0	5.0	0.0	45 Kcals
	Ghee	5.0	0.0	5.0	0.0	45 Kcals
	Cashew nuts	7.6	0.4	1.2	3.6	45 Kcals
	Roasted					
	Peanuts	7.6	0.5	1.5	3.7	45 Kcals
	Macadamia	6.5	0.4	4.6	0.1	45 Kcals
	nuts					
	Bambara	14.0	2.5	0.8	4.9	45 Kcals
	nuts					
	Sunflower	7.6	1.4	3.8	1.1	45 Kcals
	seeds					
	Sesame	7.5	1.1	4.0	0.5	45 Kcals
	seeds					
	Amaranth	37.2	1.9	0.7	7.4	45 Kcals
	seeds					
	Watermelon	7.6	2.3	3.6	0.6	45 Kcals
	seeds					
	Pumpkin	7.8	1.9	3.7	0.8	45 Kcals
	seeds					
SUGAR	Honey	6.2	0.0	0.0	5.0	45 Kcals

The information generated from these calculations was added to the existing KFEL dataset to enrich the Diet Wizard application data base. This step was necessary because the original Kenyan Food Exchange List, which was to be used during the development of the app, lacked a wide variety of commonly consumed Kenyan foods and did not include complete macronutrient data for many local items. By incorporating these new values, the application became more comprehensive and culturally relevant, enhancing its effectiveness in nutritional assessment, diet planning, and personalized dietary recommendations within the Kenyan context. The inclusion of this data also filled critical gaps in the

app's food database, making it a more useful tool for nutritionists in clinical settings. This was also reported to be done by other nutrition scholars who developed diet applications that used standard tools to help in the field of nutrition and dietetics.

Several studies made it a priority to include new, regionally relevant foods in app databases as they were being developed in order to guarantee that these resources continued to be useful across a range of demographics and dietary customs. In recent years, nutrition experts realized the limitations of depending exclusively on pre-existing food exchange lists or standard food composition tables when creating mobile or web-based nutrition applications. The Global Diet Quality Score (GDQS) mobile application, created with the React Native framework, was a noteworthy example. At first, there was a master food and beverage database with about 2,700 items in the GDQS app. However, the study team found deficiencies in the database before field deployment, particularly with regard to foods that are consumed regionally and culturally. In order to remedy this, researchers used editable Excel submissions to methodically update missing elements. Without relying on user contributions, this process enabled the application to reflect the actual dietary habits of target populations, including those in Ethiopia and other low- and middle-income nations. In several nutritional contexts, the app's accuracy and applicability were greatly improved by the intentional, researcher driven inclusion of foods (Intake.Org, 2022). Researchers also added underrepresented and recently researched foods to the original database in a machine learning-based tool project, which was then processed by a neural network algorithm. This computerized approach determined interchangeable serving sizes and categorized each item according to nutritional similarities (Hernández-Hernández et al., 2023). Research indicated that adding locally accessible and frequently eaten items to food exchange lists enhanced dietary compliance and cultural acceptance. For instance, in order to better fit local dietary patterns and increase the precision of meal planning for diabetic patients, researchers in Nigeria added indigenous

grains, tubers, and legumes to lists that already existed (Fadupin, 2009b). Moreover studies that proximately analyzed native foods not on food exchange lists in a number of studies undertaken in Ecuador made it possible to include nutrient-dense traditional foods like millet, sorghum, cassava, and leafy greens in their food exchange list (Chisaguano et al., 2023). Research conducted in Kenya which looked at the nutritional value of popular street snacks such samosas, chapati, and mandazi suggested that these food items need to be added to the Kenyan food exchange lists since they are often consumed and this would help nutritionists in the urban areas in meal planning calculations (Van & Hilda, 2002). The significance of creating exchange lists based on actual portion sizes consumed rather than only the 100g threshold was also highlighted by research conducted in South Africa (Marinangeli et al., 2017). In other recent initiatives, researchers created mobile apps and digital food exchange databases that included newly assessed food products. These resources were particularly helpful in regions with a variety of culinary traditions and helped standardize dietary recommendations (Mustafa, et al., 2020). Similarly, researchers updated the Jordan food exchange lists to reflect changing consumption patterns and nutritional concerns by adding processed and convenience foods, fortified foods, and plant-based substitutes (Bawadi et al., 2009).

4.2 A prototype application that will automate the use of the Kenyan food exchange list.

Diet Wizard was an innovative digital application developed to enhance the efficiency and precision of diet planning among professional dietitians and nutritionists. The app functioned as a comprehensive dietary prescription tool, allowing practitioners to generate individualized diet plans based on clients' unique caloric requirements. The Diet Wizard app was developed using React, a powerful JavaScript library specifically designed for building fast, dynamic, and interactive user interfaces. React enabled the creation of a single-page application that updated efficiently without needing to reload the page, resulting in a seamless user experience. For the styling and layout, Bootstrap, a popular front-end framework that

offered a wide range of pre-designed UI components and responsive grid systems was used. This ensured that the web app maintained a consistent and professional appearance across various screen sizes and devices, including desktops, tablets, and mobile phones. The coding and debugging process was carried out in Visual Studio Code (VS Code), a widely-used and highly extensible code editor well-suited for JavaScript and React development. VS Code provided essential features like IntelliSense, version control integration, and a wide selection of helpful extensions, which streamlined the development workflow. All the application's logic, including user interactions and data handling, was managed entirely on the front end using React state management and hooks. This approach simplified deployment by eliminating the need for a separate backend, making the app lightweight and easy to maintain. By integrating clinical standards and dietary exchange systems, Diet Wizard supported the user in selecting appropriate meal portions, food types, and the number of food exchanges to ensure nutritional adequacy tailored to each patient's needs. The app emphasized evidence-based nutrition assessment and intervention, aligning with current clinical nutrition guidelines and practices.

The functionality of Diet Wizard was grounded in a stepwise interactive interface that guided the user through the dietary planning process. Upon launching the application, the clinical nutritionist prompted to enter personal demographic data of the client, including name, age, and gender. This was followed by anthropometric data input height (in meters), weight (in kilograms), and activity level which were essential for generating accurate nutritional indices. The app then automatically computed and displayed the client's Body Mass Index (BMI), Basal Metabolic Rate (BMR), and total daily caloric requirements based on the entered data. This bio-data analysis component ensured that nutritional prescriptions were founded on scientifically validated estimations of energy needs.

In the food recommendation module, Diet Wizard provided a categorized list of food items tailored to the client's caloric needs, with each item listed alongside its respective food group, portion size, weight in grams, and caloric contribution. The dietitian could customize the meal plan by selecting foods that align with the client's preferences. If the initial food list did not meet client acceptability, the app offered a “Regenerate” feature that produced alternative options maintaining the required caloric balance. Furthermore, the application accommodated patients with special dietary needs by enabling manual adjustments to calorie targets while preserving the accuracy of nutrient distribution through the standardized food exchange system. By combining personalized care with technological precision, Diet Wizard represented a practical and evidence-based tool for advancing clinical nutrition practice.

Figure 4.1

Diet wizard (front page)



The front page of the Diet Wizard app was designed to be simple, attractive, and easy to navigate, allowing nutritionists to access all key features of the system without confusion. The layout and color scheme were developed to make the app welcoming and user-friendly, ensuring that even first-time users could easily understand how to use it.

Figure 4.2

Diet Wizard patient demographic information

The image shows a web application interface for 'DIETWIZARD' overlaid on a background image of a healthy meal. The interface includes a navigation bar with four items: 'Personal Info', 'Anthropo', 'Activity Level', and 'Submit', each with a corresponding icon. Below the navigation bar, a white form box contains the text 'Welcome to DietWizard!' and 'Please enter your details below'. The form has three input fields: 'Name' (a text box), 'Age' (a text box), and 'Gender' (a dropdown menu). A blue 'NEXT' button is located at the bottom right of the form box.

This page collects important background information about the patient, such as age, gender, and occupation. These details are essential because they influence nutritional needs and food choices. For instance, energy requirements differ between men and women, and age also affects dietary recommendations

Figure 4.3

Diet Wizard patient's anthropometric and activity level page

The image shows the 'DIETWIZARD' web application interface at the 'Anthropo' step. The navigation bar now has 'Personal Info' in blue, indicating it is the current step, while 'Anthropo', 'Activity Level', and 'Submit' are in grey. The white form box contains the heading 'INSTRUCTIONS:' followed by three bullet points: 'Enter your weight in KGs', 'Enter your height in meters by dividing your height by 100', and 'Select your activity level based on how active you are'. Below the instructions are three input fields: 'Height (m)' (a text box), 'Weight (kg)' (a text box), and 'Activity Level' (a dropdown menu). At the bottom of the form box, there are two buttons: a purple 'BACK' button on the left and a blue 'SUBMIT' button on the right.

On this page, users enter the patient's body measurements such as height, weight, and BMI together with their level of physical activity. The system uses these details to calculate the total energy requirements automatically. This helps nutritionists quickly determine whether a patient needs to gain, lose, or maintain weight. By including activity level, the app ensures that the dietary recommendations are realistic and personalized.

Figure 4.4

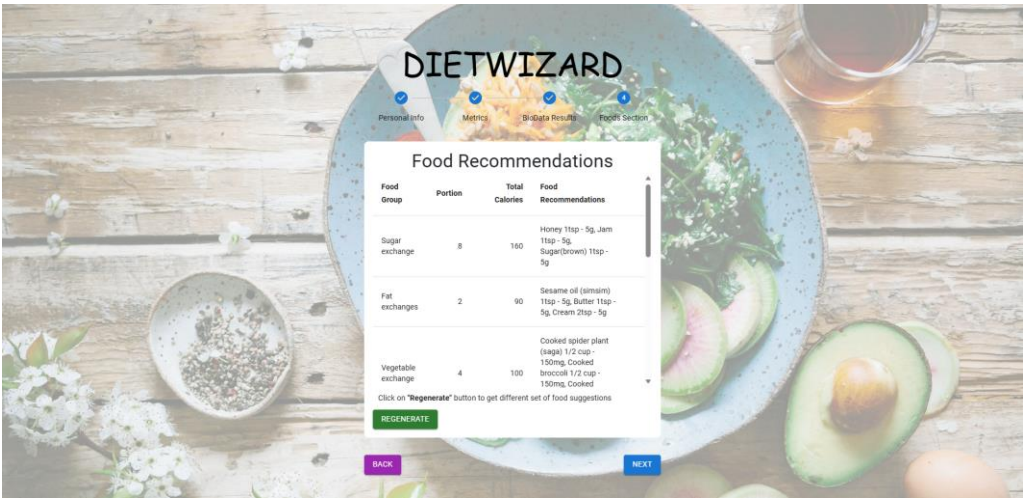
Diet Wizard bio data



The bio data page displays calculated values such as Body Mass Index (BMI), Basal Metabolic Rate (BMR), and total calorie requirements. These values are automatically generated by the system based on the data entered on the anthropometric and activity level page. The BMI helps classify the patient's weight status, while the BMR and calorie requirements guide the nutritionist in determining the right energy intake for each individual. The clear and organized layout of this page ensures that all this vital information is presented in a simple and easy-to-understand format, helping nutritionists make quick and accurate dietary decisions.

Figure 4.5

Diet Wizard recommendation page.



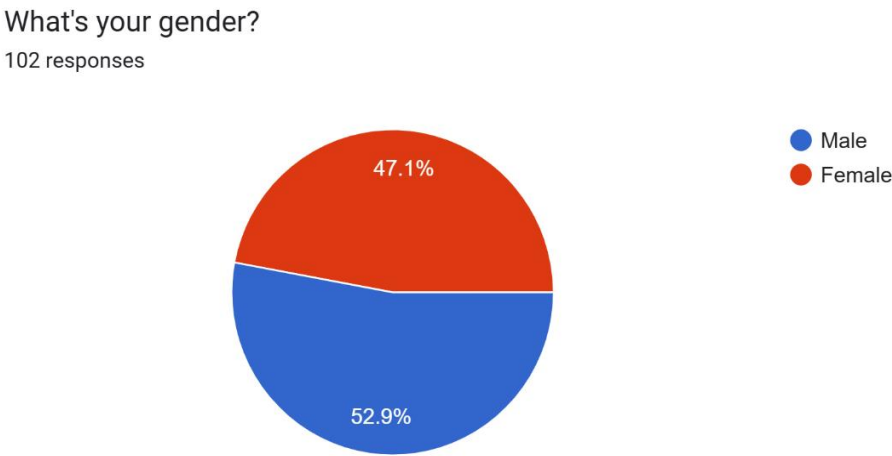
The page presents a breakdown of food groups, recommended servings, and specific food items that together meet the patient’s calculated calorie requirements. This ensures that the meal plan is both nutritionally balanced and tailored to the individual’s needs. The app allows the user to regenerate another list of food options if the patient prefers different meals or has special food preferences. This makes it easier for nutritionists to customize meal plans without repeating the entire calculation process. Overall, the recommendation page helps deliver accurate, practical, and client-centered meal plans that align with both nutritional guidelines and patient preferences.

4.3 Demographic characteristics

The demographic information obtained from the nutritionists was important because they represented the target users of the Diet Wizard application developed in this research. The study targeted 297 sample of nutritionists calculated from the total population estimated at 1300. Out of the 297 questionnaires distributed, 102 responded to the questionnaires while only 100 of those fully

answered all the questions while the remainder (2) gave responses on specific sections of the questionnaires.

Figure 4.6
Gender of the nutritionists

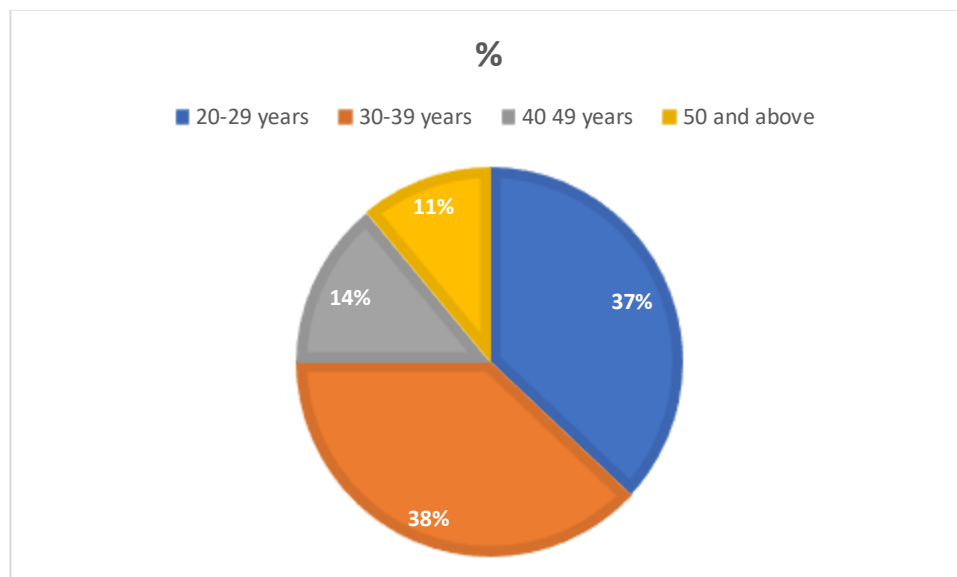


The responses illustrated the gender distribution of 102 respondents. According to the data, 52.9% were male, while 47.1% were female. This indicated a relatively balanced gender representation within the nutritionists, with a slight majority of male respondents. The difference between the two groups is minimal, suggesting that both genders were almost equally represented. However, these results were not in congruence with other findings on this area. Women had from years past both traditionally and universally dominated in the area of dietetics, a pattern that continued to this day in many different locations. Women outweighed males in this field by a large margin, according to several studies and employment data. For example, according to academic studies and statistics from the U.S. Bureau of Labor Statistics, women made up more than 90% of registered dietitians (RDNs) in the US, compared to around 10% of males (Williams et al., 2021). Other high-income nations had experienced similar trends so far. According to several surveys, between 90% and 95% of practicing dietitians in the UK and Canada were female. The profession was "overwhelmingly female,"

according to a Canadian assessment, which also highlighted the underrepresentation of males in dietetics as a possible obstacle to workforce diversification (Román et al., 2023). Although there were significant geographical differences, the gender distribution in clinical nutrition and associated health professions in low- and middle-income nations showed a similar pattern. Research on the makeup of the health workforce in Kenya revealed that 42% of healthcare professionals, including physicians, pharmacists, clinical officers, and dietitians, were men and 58% were women. This data indicated a female-dominant tendency in the nation, even though it did not precisely separate nutritionists and instead reflected the larger health workforce (Okoroafor et al., 2022). Additionally, particular gender information was not provided in Kenyan research that examined the opinions of 18 licensed nutritionists about ketogenic dietary treatment. The authors recognized that the study sample included both male and female and there was female dominance (Samia et al., 2024). The gender distribution of Human Nutrition and Dietetics graduates in Uganda was determined to be 35.6% male and 64.4% female. This illustrated the ongoing trend of female domination in the field throughout the East African area, however, the disparity was considerably smaller than in Western nations (Kikomeko et al., 2021)

Figure 4.7

Age group distribution of the nutritionists

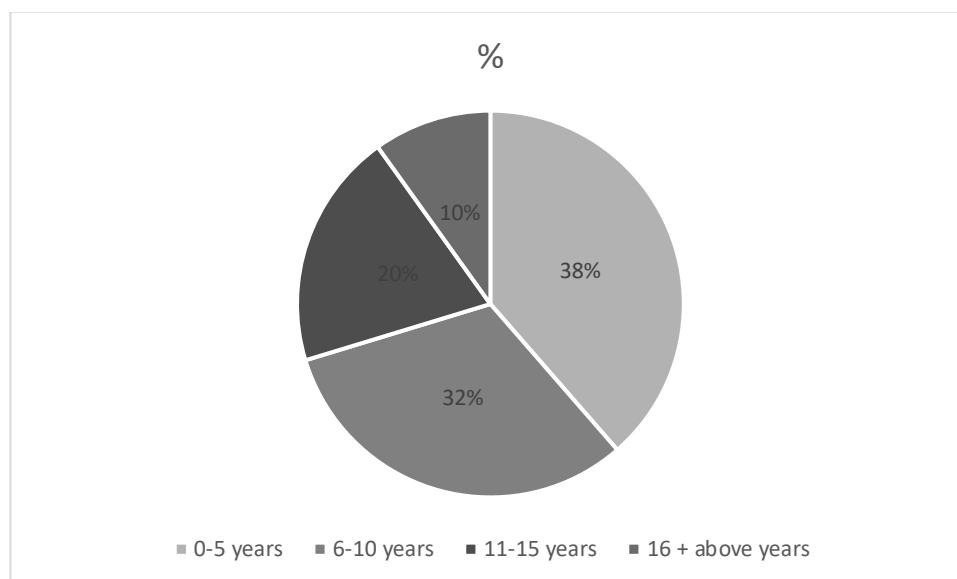


The Figure: “Age group” above summarized the age distribution of 100 respondents. The dominant age group was 30–39, which accounted for 38% of the responses. This was closely followed by the 20–29 age group at 37%. These two groups were the dominant age ranges among the participant dietitians. The 40–49 group represented 14%, while 11% of respondents were aged 50 years and above. The responses suggested that the majority of respondents were young adults and early middle-aged individuals, with 74% of participants between the ages of 20 and 39. The study's results were consistent with regional and worldwide patterns, showing that most professionals in the area of nutrition were in their early years of their careers. The age distribution of dietitians and nutritionists in Kenya was not well documented, although surveys and qualitative research suggested that the workforce was young. One research, for example, that looked at the usage of ketogenic diet treatment among Kenyan nutritionists found that most of the participants were young professionals, mostly under 40 (Samia et al., 2024). A rising interest in and recent growth of nutrition and dietetics training programs at Kenyan institutions was mirrored in this age profile. There was a similar trend

in the age distribution of nutritionists worldwide. 47.2% of the 142 nutrition experts surveyed in India were between the ages of 18 and 29, and 50.7% were between the ages of 30 and 49, according to a cross-sectional survey.(Mathew et al., 2023) . A multi-country survey of healthcare workers revealed similar results, with 43.2% of participants being between the ages of 21 and 30 and an average age of 34.4 ± 10.2 years (Vasiloglou et al., 2020). These results suggested that, on a worldwide scale, the clinical nutrition and dietetics area was mostly made up of young professionals. The trend in the UK was a little off in favor of an older average age where, the mean age of UK dietitians taking part in low-energy diet programs was 40.8 ± 9.5 years, with the interquartile range being 34–49 years old, according to 2022 research (Brown et al., 2022). Similarly, another study of nutritionists with a focus on gut health found that 71% of participants were between the ages of 26 and 35 highlighting the predominance of young practitioners (Williams et al., 2023). According to statistics from the statistics USA platform, the average age of dietitians and nutritionists in practice in the US was around 41.9 years old. The sector nevertheless included a sizable percentage of younger professionals, especially in clinical jobs, even if this indicated a more mature workforce as compared to emerging nations. Older nutritionists frequently moved into consulting, academia, or private practice. The majority of younger professionals was a reflection of changing healthcare needs, growing educational options, and growing knowledge of the importance of nutrition for health. However, as seasoned clinicians retired or moved into non-clinical professions (Oliver et al., 2022).

Figure 4.8

Years of experience as a clinical nutritionist



The figure above, represented responses from 101 individuals, showing the distribution of professional experience in the field. The mode portion of respondents, 38.6%, have 0–5 years of experience. This indicated that a significant number of clinical nutrition professionals were relatively new to the field. 31.7%, has 6–10 years of experience, showing a stable core with a moderate level of experience. Dietitians with 11–15 years of experience accounted for 19.8% of the respondents, while only 9.9% had 16 years or more of experience. 38.6% of respondents reported had 0–5 years of experience, indicating that a sizable fraction of nutrition practitioners was relatively new to the industry, according to the study's findings. This is in line with previous study findings from throughout the world. According to research done in Australia, for instance, more than half of the nutritionists employed by residential aged care institutions had between 0 and 5 years of experience (Hughes et al., 2020). Similarly, a study done in the United States found that 32.3% of nutritionists had 0–5 years of experience, and it was the most prevalent experience bracket (Grandy & Holcomb, 2018). These numbers implied that the field

was drawing a sizable number of new members, maybe as a result of growing demand for nutrition services, training facility growth, and more awareness of the importance of nutrition in health.

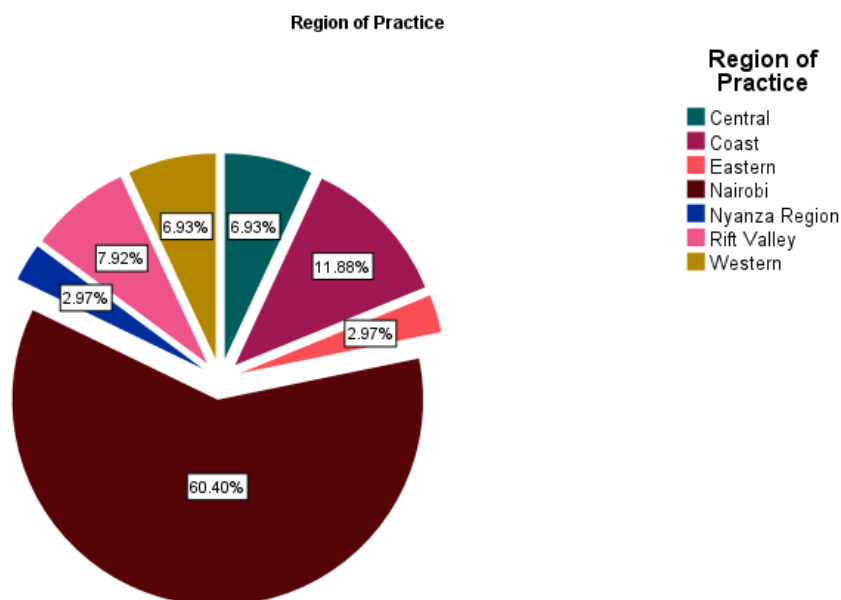
31.7% of participants in the present survey said they had 6–10 years of experience, while 19.8% said they had 11–15 years. This was consistent with findings from other research and represents a sizable population of professionals in their mid-career. For example, according to a European study of nutritionists working in nutrigenomics, around 30.8% of respondents had six to fifteen years of experience (Fallaize et al., 2019). As they assume greater responsibility in clinical, academic, or public health contexts, these mid-career professionals were probably the backbone of the discipline, offering leadership and real-world experience. Their existence suggests a steady and knowledgeable workforce that can guide new hires and influence the direction of the industry.

Only 9.9% of the respondents had 16 years or more of experience, according to the research. Only a tiny portion of nutritionists had more than 15 years of experience, a tendency that was also noted in previous studies (Fallaize et al., 2019; Hughes et al., 2020). The comparatively low percentage of seasoned professionals would be due to a number of reasons, including career changes, retirement, or the relatively recent expansion of the field in some areas.

A multi-country study of healthcare professionals, including dietitians, revealed that a sizable percentage of respondents were just starting their professions. These findings were also supported by other studies. The average professional age was 34.4 ± 10.2 years, indicating that the majority were in their first decade of practice, and 43.2% of respondents were between the ages of 21 and 30 (Maillot et al., 2021).

Figure 4.9

Region of practice as a nutritionist in Kenya



The Figure 12 above, "Region of Practice" illustrates the distribution of Nutrition professionals across different regions of Kenya. It revealed that the majority of practitioners who participated in the research, 60.40%, were based in Nairobi, which accounted for a substantial number of nutritionists. This is an indication of a significant centralization of the practice within the capital. The Coast region followed distantly with 11.88%, Western 6.93%, Central 7.92%, and Rift Valley regions 6.93% contributed to relatively similar proportions. Eastern and Nyanza Region had the lowest representation at 2.97%. The responses highlighted a high population of practitioners in Nairobi, with the rest of the regions sharing the remaining percentage in a more significantly smaller distribution. In other studies, nutritionists were found to be quite unevenly distributed throughout Kenya, with a significant concentration in urban regions. Nutritionists in practice were most prevalent in Nairobi, Mombasa, Kisumu, and Kisii. Private hospitals, non-governmental

organizations, and donor-funded initiatives all of which were mostly located in metropolitan areas all had an impact on this trend. Many nutritionists, worked at prestigious private and public hospitals in Nairobi, such as Nairobi Hospital and Aga Khan University Hospital and Kenyatta hospital (WHO, 2017). As regional centers, Mombasa and Kisumu housed a moderate number of nutritionists in both public and private healthcare institutions. One of the few rural regions that had effectively hired about 35 nutritionists was Kisii County (Kiprono, 2021). Conversely, there were either extremely few or no nutritionists in remote and desert counties including Lamu, Isiolo, Wajir, Turkana, and Marsabit. Notwithstanding the significant prevalence of hunger and nutrition-related disorders, many public hospitals in these regions did not have specialized nutrition staff. This showed a significant gap in nutrition service provision between urban and rural areas. Interestingly, despite the fact that more than 13,000 dietitians and nutritionists were registered in Kenya, over 7,000 of them were still jobless. According to the statistics, the problem was not a lack of specialists but rather a lack of work possibilities, particularly in the public and rural health sectors (Maina, et al., 2018).

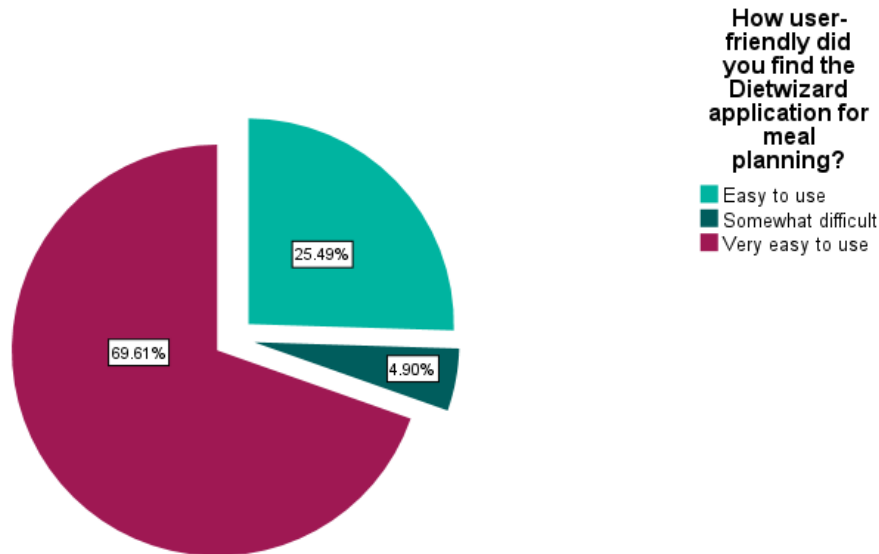
Nutritionists provided patient treatment in just around 30% of Kenyan hospitals, most of which were private and situated in cities. This resulted in a significant void in public health, since nutrition services were frequently disregarded or given little attention (Samia et al., 2024).

4.4 Diet Wizard app feasibility

Figure 4.10

User friendliness of the Diet Wizard application

Pie Chart Percent of How user-friendly did you find the Dietwizard application for meal planning?



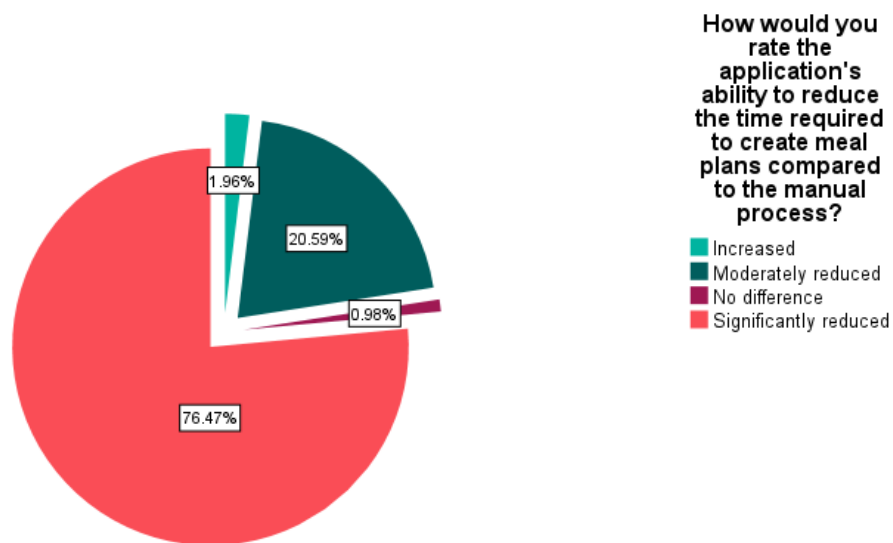
To understand the feasibility of the application, the pie chart above illustrated user feedback on the user-friendliness of the Diet Wizard application for meal planning. 69.91% who were the majority of respondents, found the application to be very easy to use, indicating a high level of satisfaction with its interface and functionality. In addition to that, 25.49% of users rated the app as easy to use, suggesting that it was generally intuitive and accessible. A small portion, 4.90%, reported that they found the application somewhat difficult to use. Overall, the responses showed that 95.1% of users had a positive experience, demonstrating that the Diet Wizard application was largely user-friendly. These results were in agreement with a study that found out 93% of users expressed satisfaction with the diet app, app's usability and navigation features, highlighting its straightforward design and useful layout for daily usage (Chen et al., 2018). A comparable study showed that most users valued the apps' responsiveness,

streamlined design, and ease of data entry, all of which had a major impact on their propensity to keep using them in clinical settings (Zhou et al., 2025). Although the program was generally functional, there is still room for slight changes in the user interface design, particularly for inexperienced or less knowledgeable about technology users, as seen by the tiny percentage of users (4.90%) in the present survey who considered it rather challenging to use. Well-designed diet applications needed to include user feedback on a regular basis to improve accessibility, especially for older or less tech-savvy people (Lin et al., 2005).

Figure 4. 11

Diet Wizard application's ability to reduce time required to create manual meal plans

Pie Chart Percent of How would you rate the application's ability to reduce the time required to create meal plans compared to the manual process?



The pie chart presented in Figure 13 shows user responses on how they rated the Diet Wizard application's ability to reduce the time required to create meal plans compared to the manual process. The majority of respondents, 76.47%, indicated that the application significantly reduced the time needed, suggesting that the tool was highly efficient in streamlining the meal planning process.

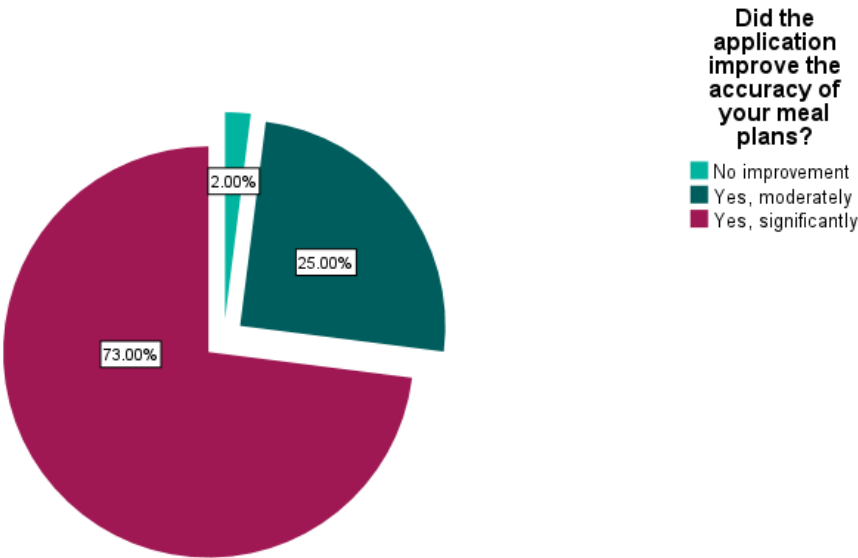
Additionally, 20.59% of users stated that the time was moderately reduced, reflecting a generally positive impact, though to a lesser extent. A very small percentage, 1.96%, felt that the application increased the time required, and 0.98% saw no difference compared to manual methods. Overall, according to the responses, over 97% of users experienced a reduction in time spent on meal planning, highlighting the application's effectiveness in enhancing productivity and simplifying the process. The feedback although minimal negative suggested that while improvements may be beneficial for a small number of users, the application was largely successful in achieving its goal of time efficiency. A large number of research participants agreed that using the diet app simplified the diet planning process and cut down on the time and effort usually required for manual approaches. This opinion was in line with other studies' conclusions, which highlighted how digital technologies may help health professionals and individual users perform more efficiently. For example, research discovered that users thought diet apps were time-saving, especially when it came to chores like recording food categories, meal planning, and calorie counting, which require a lot of effort and nutritional expertise when done by hand (Fallaize et al., 2019). Additionally, smartphone applications minimized the need for lengthy consultations and paper-based computations by providing quick access to food databases, automated nutrient analysis, and simple meal plan production, according to nutritionists and other health professionals. In another study, mobile health interventions greatly decreased the amount of time nutritionists needed to create customized meal plans, allowing them to provide more effective client care(Wang et al., 2018). In a similar study, diet apps with built-in meal plans and nutritional calculators improved time management for practitioners and users. According to the results of their experiment, 83% of users finished diet planning in 10 minutes while using the app, as opposed to more than 30 minutes when using manual methods(Chen et al., 2018). All of these results gave support to the idea that diet planning apps might be quite

helpful in dealing with time restrictions, particularly for those who are managing several patients with special dietary requirements or in hectic clinical environments. This idea was supported by this study, which found that the application greatly reduced the time required to generate meal plans, making it a useful and enticing tool for everyday usage.

Figure 4. 12

Diet Wizard improved the accuracy of meal plans

Pie Chart Percent of Did the application improve the accuracy of your meal plans?



The pie chart above illustrates user feedback on whether the Diet Wizard application improved the accuracy of their meal plans. A large majority of respondents, 73.00%, reported that the application significantly improved the accuracy of their meal plans. Additionally, 25.00% indicated a moderate improvement, showing that the application positively impacted meal planning accuracy for nearly all users. Only 2.00% of respondents stated that there was no improvement. This data strongly suggests that the Diet Wizard application was highly effective in enhancing the precision of meal planning for users. With 98% of users experiencing some level of improvement, the application appeared to deliver on its promise to support accurate and effective meal planning compared to the 82.2% overall feedback on the

KEFL. This view was in line with research from earlier studies that showed how meal planning by use of digital tools improved dietary advice accuracy by automating nutritional calculations and offering organized food databases. In a study, users of diet apps reported increased nutritional diet planning accuracy, mostly as a result of linked food databases that reduced human error during meal planning (Chen et al., 2018). Similarly, another study discovered that because mobile diet apps allowed for real-time recording and amount estimate, users were able to plan meals more accurately than those who used conventional techniques (Hutchesson et al., 2015). Earlier researchers also showed that dietitians found the use of applications that provided culturally appropriate food selections and regional food exchange systems significantly improved the accuracy of customized meal plans. Professionals were able to generate accurate meal plans, this helped them create individualized and trustworthy diet programs more quickly because to these technologies (Kovach, 1995). Users of a culturally tailored diet planning software expressed greater satisfaction with the precision of meal and nutrition planning, particularly when the program took into account regional food availability and dietary customs (Hattab et al., 2022b). According to Turner et al. (2013), the simplicity of use and continuous feedback aspects of mobile apps helped users in weight control programs track and schedule their meals more accurately and consistently than non-users (Turner et al., 2019). The diet planning applications increased the accuracy and effectiveness of meal planning, confirming the importance of digital apps in clinical and individual nutrition practice.

Figure 4.13

Diet Wizard application in enhancing patient care through improved meal planning

Pie Chart Percent of Do you believe that the Dietwizard application could enhance patient care through improved meal planning?

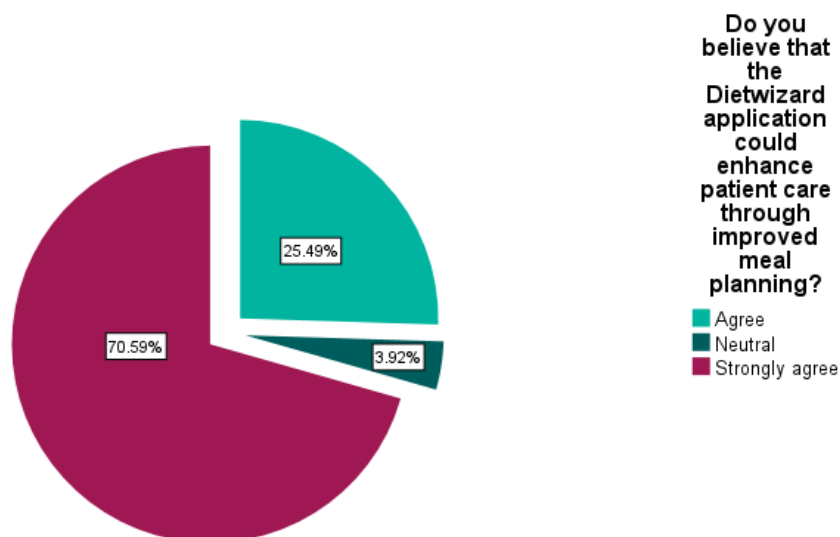


Figure 16 above illustrates respondents' opinions on whether the Diet Wizard application could enhance patient care through improved meal planning. A significant majority, 70.59%, strongly agreed that the application had the potential to positively impact patient care. Additionally, 25.49% of respondents agreed with this statement, further reinforcing the belief in the application's effectiveness. Only a small minority, 3.92%, remained neutral, indicating limited uncertainty or lack of opinion on the matter. Generally, the data revealed a strong positive perception of the Diet Wizard application, with over 96% of participants expressing confidence in its ability to improve patient care through more effective meal planning. A similar study showed that integrating their Diet Diary app for 12 weeks greatly improved nutritionist' self-efficacy in recommending and using diet apps in clinical settings. In the research, both patients and practitioners expressed a desire to keep using the app(Chen et al., 2018). A self-efficacy tool for nutritionists demonstrated high internal reliability, particularly in areas

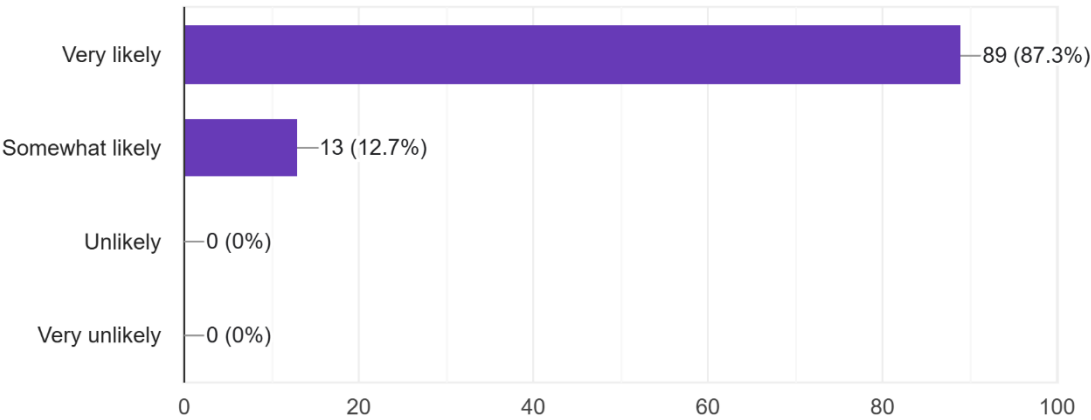
pertaining to app usage and integration into regular work systems in a comparable study (Jospe et al., 2015). Furthermore, according to a global study of sports dietitians, one-third of them already tracked and evaluated their diets using apps like MyFitnessPal, and the majority of them said that these tools were just as beneficial as or even more so than conventional approaches (Evans, 2017) .In a different study, nutritionists highlighted the significance of user-centered design elements, which were considered necessary to improve usability and professional adoption. These features included nutrient breakdowns, culturally relevant food databases, and clear portion-size visuals (Ebrahim et al., 2019).

Figure 4.14

Adoption of diet wizard application in clinical practice by nutritionists

How likely are you to adopt the Dietwizard application as part of your daily practice if fully developed and integrated?

102 responses



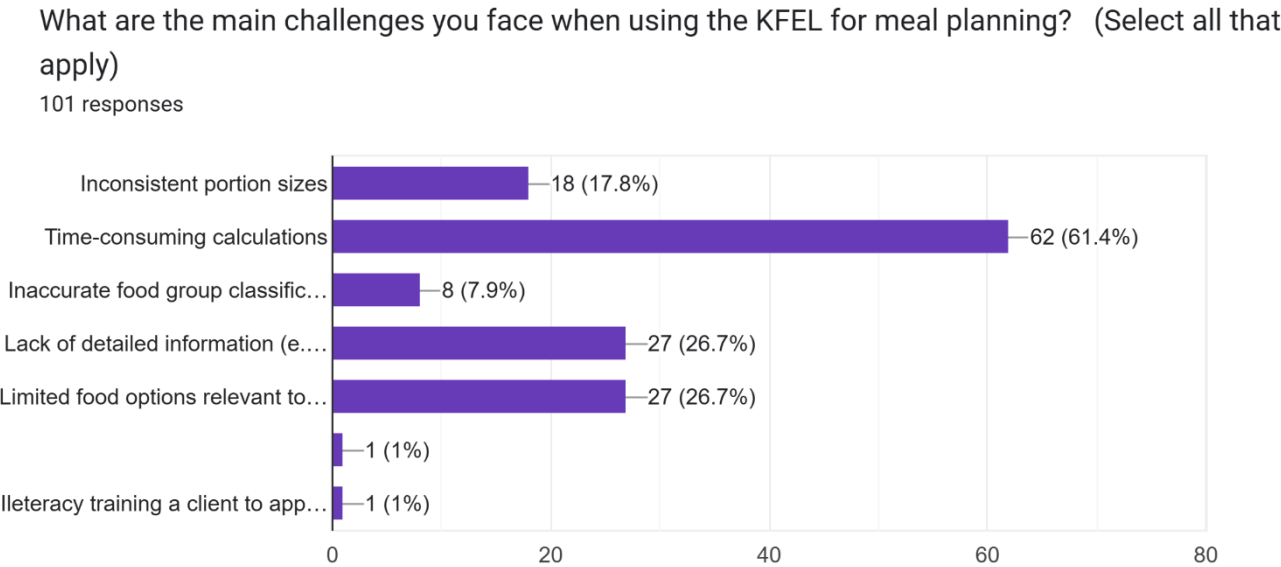
After conducting the analysis, it was essential to determine if the nutritionists would prefer the Diet Wizard as their preferred tool. The survey results indicated a highly positive outlook toward the adoption of the Diet Wizard application among respondents. Of the 102 participants, an overwhelming 87.3% stated that they are "very likely" to incorporate the application into their daily practice if it is fully developed and integrated. An additional 12.7% reported being "somewhat

likely" to adopt the tool, while no respondents expressed reluctance or opposition, with 0% selecting "unlikely" or "very unlikely." This unanimous openness to adoption highlights a strong demand for improved digital tools in meal planning and nutrition management. The high level of interest suggested that if the Diet Wizard application effectively addressed existing challenges such as time-consuming calculations and limited relevant food options, as identified it could become an essential component of users' professional routines. Numerous studies have assessed how mobile applications might enhance nutritional outcomes and make nutrition experts' jobs easier. Another study developed a carbohydrate counting app that uses picture recognition to help those with low reading levels with arithmetic and nutrition(Alfonsi et al., 2020). Similar to this, a color-coded food exchange system in Qatar was created that was especially designed to help those with lower literacy levels choose meals, highlighting the need for easily navigable and straightforward digital solutions (Bawadi et al., 2022). Similar advancements were noted in Korea, where researchers effectively supported nutrition counseling sessions using the Nutrisonic app, an automated system based on food exchanges(Hong et al., 2008). The viability of a customized nutrition tracking program (Good Measures) that enabled virtual communication between patients and nutritionists via desktop and mobile devices was also investigated by Olfert et al. (2019). Similar to the current study, these investigations demonstrated the increasing viability of integrating digital platforms into the provision of nutrition services. Furthermore, another study looked into how users interacted with a self-regulation health app and discovered that while some users had technical difficulties, most participants said it was simple to use and time-saving. These findings highlighted how crucial user support and usability testing are when launching new digital health products (Degroote et al., 2020). The aforementioned results were also consistent with research that showed that food exchange lists created by algorithms could be finished in a matter of seconds, removing the inconsistencies and

inefficiencies that came with manual computations (Dholvitayakhun & Kluabwang, 2014). In a similar view, our program allowed for quicker meal planning than dietitians had previously found labor-intensive and time-consuming manual usage of the Kenyan Food Exchange List (KFEL). The usefulness of mobile applications in assisting with therapeutic nutrition treatments had also been shown by other international investigations. For instance, studies using diet-focused apps to monitor weight loss in overweight populations (Chen et al., 2018), improved food intake among dialysis patients (Gassmi Hospital study), and managed childhood obesity all showed better results when apps were used for diet tracking and professional follow-up(Browne et al., 2020). Through their software "Manager," Ali et al. (2017) also demonstrated the usefulness of substituting digital input for manual meal records, which increased patient compliance.

Figure 4.15

Main challenges nutritionists face when using KFEL for meal planning manually

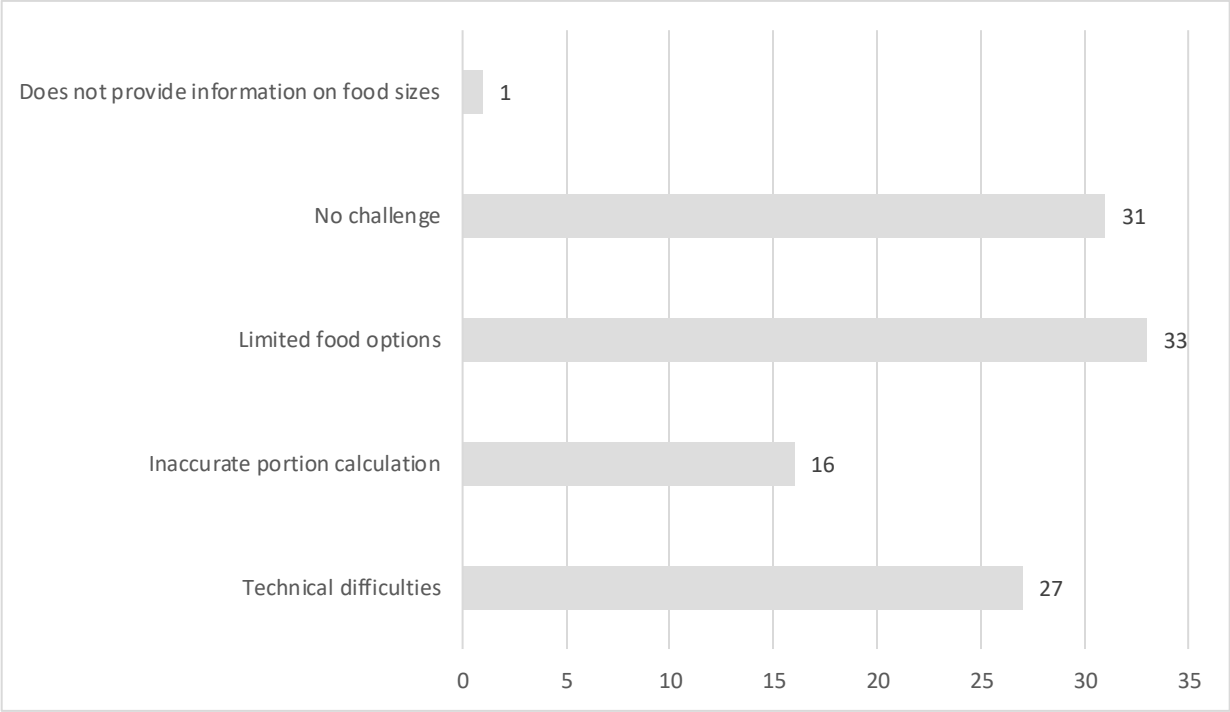


In order to develop Diet Wizard to be effective it was necessary to analyse the KFEL and solve the challenges faced by dietitians and as a result provide a solution. The bar chart illustrates the main

challenges users faced when using the KFEL for meal planning manually, based on responses from 101 participants. The most frequently cited issue was time-consuming calculations, reported by 62 respondents (61.4%), indicating inefficiency in this area. The lack of detailed information and limited food options relevant to clients were selected by 27 respondents each (26.7%), showed that users struggle with gaps in the database and contextual applicability. Inconsistent portion sizes were noted by 18 respondents (17.8%), and inaccurate food group classification were mentioned by 8 respondents (7.9%), suggesting some problems with precision in the tool's categorization and measurements. Less commonly reported were issues related to literacy training a client to apply the tool, selected by only 1 respondent (1%), indicating that user education or training was a minimal concern. Overall, while the KFEL was a useful tool, many users faced substantial challenges related to its complexity, relevance, and comprehensiveness. These challenges mirrored findings from other research studies. For instance, (Kovach et al.,1995) noted that nutritionists often struggled with the manual nature of dietary calculations, describing them as both time-consuming and mentally taxing. Potential errors in meal planning among the nutrition practitioners recognized early on the need for computerized systems to streamline menu planning and reduce the cognitive load on nutrition professionals (Balintfy, 1964). A study emphasized how difficult meal planning might be because of gaps and discrepancies in food data, which was in line with users' complaints about KFEL's irregular portion sizes and incorrect food category classifications (Yusof & Noah, 2017) Nutritionists' capacity to create meal plans that were both culturally appropriate and nutritionally balanced was severely hampered by these data disparities. Similarly, another study emphasized the importance of digital advances and expert systems that not only reduced nutritionists' effort but also improved the accuracy of nutritional information. According to their results, nutrition planning tools would incorporate user-centered design concepts to guarantee that practitioners' needs

would be met (Mustafa ,et al., 2020). The importance of user needs for nutritional assistance systems was also highlighted such as, the need for comprehensive databases, culturally relevant food products, and thorough food composition data (Payne et al., 2015). The KFEL is very deficient in many areas, which restricts its ability to accurately represent the dietary diversity of Kenyan populations. The KFEL's restricted food selection and overall lack of contextual depth make it difficult to customize diets for particular groups with particular nutritional requirements, such infants, expectant mothers, or those with long-term conditions.

Figure 4. 16
Challenges faced by the respondents while using Diet Wizard app



The bar chart highlights the various challenges users encountered while using the Diet Wizard application. The most commonly reported issue was limited food options, with 33 users identifying this as a concern. Technical difficulties followed closely behind, cited by 27 users, suggesting that software reliability or usability might be problematic for many. Inaccurate portion calculation was mentioned by 16 users, indicating a moderate concern around the application's accuracy in dietary

measurement. Interestingly, 31 users reported no challenges, showing that a substantial portion of users had a positive experience with the app. Only 1 user noted a lack of information on food sizes, suggesting this issue is minimal or rare. While many users found the application effective, there were clear areas particularly food variety and technical stability that would need improvement. In other studies, Internet dependence and gadget incompatibility were also noted as obstacles for mobile apps particularly for users in low-resource or rural environments. According to other research, infrastructure constraints like erratic internet connectivity and outdated mobile devices frequently undermined the efficacy of digital health solutions in low- and middle-income nations (Payne et al., 2015). Another recurrent concern in previous studies was inadequate training and user assistance. Numerous users expressed hesitancy about using the app's more complex functions or resolving issues. This is in line with findings that discovered t inadequate in-app instructions and onboarding pose serious obstacles to healthcare practitioners' successful adoption of mHealth applications.(Tang et al., 2015).A high percentage 31% of the users, did not find any challenge using the application and 87.3 % approved the app to be helpful in solving diet planning issues that dietitians face in their everyday life at work.

Table 4.3
Comparative analysis of diet wizard and similar nutrition applications

App/Study	Clinical Suitability	User-Friendliness	Innovation	Overall	Target Group	summary
Good Measures (Olfert et al., 2019)	High	Moderate	High	1	Healthcare professionals and patients	Versatile, strong counseling features; adaptable for diverse populations.
Diet Wizard	Very High	High	Very High	2	Dietitians in Kenya	Clinically tailored innovative, user-friendly,

						and suitable for low-resource settings.
My Day Plan (Degroote et al., 2020)	Low	Very High	Moderate	3	Adults	Extremely user-friendly less clinical focus.
KELA App (Fakih et al., 2020)	Very High	Moderate	Moderate	4	Dialysis patients	Strong clinical use for dialysis patients; limited general use and localization.
Manager App (Ali et al., 2017)	Moderate	High	Moderate	5	Adults over 40	Simple, easy-to-use tool; practical but limited in innovation and application.
Nutrisonic App (Hong et al., 2008)	High	Low	High	6	Clients in Korea	feature rich but lacks adaptability and ease of use

The table compared six nutrition-related apps based on clinical suitability, user-friendliness, innovation, overall ranking, and target users. *Diet Wizard*, developed for Kenyan nutritionists ranked second overall and received very high ratings across all key categories. It scored well for being clinically tailored, user-friendly, and suitable for low-resource environments. *Good Measures* came first, with high clinical value and versatility, serving both healthcare professionals and patients. *My Day Plan* ranked third, showing excellent user-friendliness but limited clinical depth, targeting general adult users. *KELA App* was highly suitable for dialysis patients but lacked broad applicability. *Manager App*, used by adults over 40, was practical and easy to use but offered moderate innovation. Lastly, *Nutrisonic App* had strong features and high innovation but ranked lowest in user-friendliness, limiting its adaptability. Overall, *Diet Wizard* stood out as a balanced,

locally relevant tool, combining innovation and clinical strength in a way that supported nutritionists in Kenya effectively.

4.1 Chapter Summary

Chapter Four presented the results and findings from the research aimed at assessing the analysis of selected foods samples to be added to the existing food exchange list to add on app data base, development of the app, feasibility of the newly developed Diet Wizard application and demographic distribution of nutritionists in Kenya, the demographic section reveals a near gender parity among the 102 respondents, with males slightly leading at 52.9%. In examining the household and metric measures in KFEL, over 75% of participants indicated inconsistency or uncertainty. Diet Wizard, a digital tool designed to enhance efficiency and precision in dietary planning using KFEL list integrates biometric data input, automatic caloric need computation, and evidence-based food recommendations. Responses showed that the most significant issues with KFEL are time-consuming calculations and limited food options and in contrast, the Diet Wizard is seen as a user-friendly and effective solution that could improve workflow and dietary accuracy.

CHAPTER FIVE: CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

This chapter presents the summary of the major findings of the study, drawing key conclusions based on the research objectives and results. It also provides practical recommendations aimed at addressing the identified issues and improving future practices. In addition, this chapter suggests areas for further studies to expand on the current findings and provide deeper insights into the topic

5.1 Conclusion

This study successfully addressed gaps in the Kenyan Food Exchange List by analyzing 48 locally consumed food samples and determining their actual nutrient composition using laboratory measurements and standard values from the Kenyan Food Composition Tables. The incorporation of this new data enriched the Diet Wizard application's database, making it more comprehensive, culturally relevant, and effective in supporting accurate nutritional assessment, diet planning, and personalized dietary recommendations for Kenyan populations. The research led to the findings of this study demonstrate that the Diet Wizard application significantly enhanced both the efficiency and accuracy of meal planning among nutrition professionals. A notable 73% of respondents reported substantial improvements in meal plan accuracy, and 76.47% indicated significant time savings in their planning processes. Usability was also rated highly, with 95.1% of users expressing positive experiences 69.91% found the application very easy to use and 25.49% rated it as easy. This reflects the tool's user-friendly interface, making it accessible even for nutritionists with less experience in digital tools. Despite a slightly higher number of male respondents (52.9%), the profession remains predominantly female. Most users were between the ages of 20–39 years, and a significant proportion (38.6%) had 0–5 years of professional experience, pointing to a younger demographic that may drive the adoption of such innovations. Additionally, a large number 87.3%

of nutritionists expressed a strong willingness to adopt Diet Wizard in their practice, confirming its practical relevance. The study highlighted a strong demand for digital solutions in clinical nutrition and emphasized the importance of automating the Kenyan Food Exchange List (KFEL). Integrating such tools into routine practice could improve service delivery, optimize patient outcomes, and support modern approaches to nutritional care in Kenya. It will also enable nutritionists to use less time to create meal plans and more time to be applied on the nutrition counselling of the patients. The coverage making meal plans for patients who need special diets will also be increased by adoption of digital tools.

5.2 Recommendation

1. In order to assist nutritionists in providing precise, effective, and customized nutrition care, digital solutions like the Diet Wizard program should also be used and integrated into national nutrition guidelines. Integrating digital tools like Diet Wizard into national guidelines will enhance precision in nutrition care. This would provide evidence-based nutritional planning in a variety of healthcare settings in addition to modernizing clinical nutrition services.
2. To confirm the scalability and long-term effects of such technologies on patient outcomes and professional workflows, more investigation and pilot implementation initiatives are advised.
3. According to the study's findings, the Kenya Nutritionists and Dietitians Institute (KNDI) and other relevant organizations to work with the Ministry of Health to prioritize the revision of the Kenyan Food Exchange List (KFEL) by addition of variety of foods and include their metric measures this will help nutritionists in meal planning.

5.3 Further research

1. More pilot programs should be done by other researchers to test the long-term impact of the Diet Wizard app.
2. Further research and feasibility studies are recommended to assess the scalability and long-term impact of such technologies on patient outcomes and clinical workflows.
3. Moreover, further research should be conducted to enrich the list of foods in the food exchange list by including a wide variety of foods which are listed in the Kenyan food composition tables.

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APENDICES

APPENDIX I work plan

Work plan

TASK/PERIOD	JANUARY - MARCH 2022	MARCH - SEPTEMBER 2022	OCTOBER - DECEMBER 2023	JANUARY - AUGUST 2024	SEPTEMBER - OCTOBER 2024	NOVEMBER - MAY 2025	AUGUST 2025	SEPTEMBER - OCTOBER 2025
Development of research project topic								
Writing of the proposal								
Prototype app development								
Data collection								

Data analysis								
Writing of thesis								
Submission of thesis For departmental defense								
Submission of the Thesis for examination and oral exam								

APPENDIX II Budget plan

Table 5: Budget plan

MATERIALS/ACTIVITIES	AMOUNT
Stationary	4,000
Purchasing Kenyan cultural foods	20,000
Lab experiment	5,000
System development	30,000

Mobile credit for calls	3000
Editing report	1000
Printing thesis report	3000
Data analysis	4000
Binding	1000
Mobile data	10,000
Traveling (costs and expenses included)	10,000
Printing thesis report	5000
Binding	1000
Publishing	50,000
Total	147,000 KSH

APPENDIX III DATA COLLECTION TOOLS

Analysis DATA SHEET for the selected kenyan foods to be added to the diet wizard app

Food sample	sample size	sample 1(g)	sample 2(g)	sample 3(g)	avarage(g)
Biscuit	1 piece (2 1/2 inches)				
Pancake	1/2 medium size				
Mandazi	½ medium size				
Millet (ugali)	1/3 cup				
Cassava meal (ugali)	1/3 cup				
Cow pea cooked	1/2 cup				
Cooked pumpkin	1/2 cup				
Green grams	1/2 cup				
Cooked lentils	1/2 cup				
Cooked chick pea	1/2 cup				
Cooked butternut	1/2 cup				
Corn boiled maize cob	1/2 cob				
Yams	1/2 cup				

Goat milk	250ml
Cashew nuts	1/3 cup
Roasted Peanuts	¼ cup
Macadamia nuts	1/3 cup
Bambara nuts	1/3 cup
Sunflower seeds	3 tbsp
Sesame seeds	3 tbsp
Amaranth seeds	¼ cup
Watermelon seeds	¼ cup
Pumpkin seeds	3 tbsp
Cooked spinach	1/2 cup
Cooked kales	1/2 cup
Cooked cabbage	1/2 cup
Cooked amaranth leaves	1/2 cup
Cooked okra	1/2 cup
Cooked cauliflower	1/2 cup
Cooked Jute mallow (mrenda)	1/2 cup
Cooked cucumber	1/2 cup
Cooked nightshade (managu)	1/2 cup
Cooked spider plant (saga)	1/2 cup
Cooked pumpkin leaves	1/2 cup
Pineapples	1 cup
Watermelon	1 cup
Papaya	1 cup
Guava	1 medium size
Passion fruit	1 piece
Lime	1 small
Lemon	1 medium size
Mango	1 medium size
Tree tomato	1 fruit
Dates	5 dates
Corn oil	1 tsp
Lard	1 tsp
Ghee	1 tsp
Honey	1 tsp

Standard Kenyan food exchange list for meal planning

List	Portion size per serving	Amount (ml or g)	CHO	PRO	Fats	Kcal/ serving
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Starch	• ⅓ cup arrowroots	30g	• 15 • 15 • 15 •	• 2 • 2 •	• - • - •	80
	• ⅓ cup Ugali		15 • 15 •	2 •	- •	
	• 1 slice bread,		15 • 15 •	2 •	- •	
	• ⅓ cup cassava		15 • 15 •	2 •	- •	
	• ½ cup cooked bananas		15 • 15	7 •	- •	
	• ½ cup dried		• 15	2 •	- •	
	cooked beans			2 •	- •	
	• ½ cup			2 •	-	
	cooked rice,			2 •	-	
	• ½ cup cooked pasta,			• 2	-	
	• ½ cup sweet potatoes,					
	• ½ cup porridge,					
	• ½ cup Irish potatoes,					
	• ½ chapatti					
Milk	• 1 cup fresh milk, □	• 250 ml	• 12 •	• 8 •	• Trace	• 90
• Nonfat	• ¼ cup ice cream,	• 250ml	12	8	• 5	• 120
• Low fat	• 75 ml or one scoop,	• 250ml	• 12	• 8	• 8	• 150
• Whole	• 1 cup yoghurt					

Meat • <i>Lean</i> • <i>Medium fat</i> • <i>High fat</i> • <i>Egg</i>	• Size of matchbox meat, • palm size of fish, • a leg, thigh or breast chicken, • 2 tbsp peanut butter, • ½ cup fresh beans, • ½ cup Omena	• 30g • 30g • 30g • 30g	- - - -	• 7 • 7 • 7 • 7 •	• 3 • 5 • 8 • 3 •	• 55 • 75 • 100 • 75 •
Vegetables	• ½ cup cooked vegetables, • 1 cup raw vegetables, • 1gram tomato,	100-150g	5	2	-	25
Fruits	• 1 small apple, • peach, orange or pear, • ½ cup orange, apple or grape fruit juice(pure juice) • ¾ cup diced fruits	Varies	15	-	-	60

Fats	• 1 tsp margarine or oil, • 10 large peanuts, • $\frac{1}{8}$ medium avocado, • 1 slice bacon, • 1 tbsp shredded coconut, • 1 tbsp cream cheese, • 1 tablespoon salad dressing, • 5 large olives		-	-	5	45
Sugar	1 tsp		5			20

Diet Wizard Questionnaire

Questionnaire on Automating the Kenyan Food Exchange List with the Diet wizard Application:

I hereby give my consent to participate in this research study done by *Catherine Omwoyo*, which is designed to evaluate the feasibility and efficacy of the Diet Wizard application for the purpose of automating the Kenyan Food Exchange List in meal planning. I am aware that my participation is entirely voluntary, and I have the right to withdraw at any time without incurring any repercussions. I understand that my responses were kept confidential and used exclusively for research objectives. I also acknowledge that the study has been approved by the appropriate ethics committee and that all necessary precautions have been taken to safeguard the confidentiality of the information I provide and my privacy. I hereby confirm my consent to participate in this study.

1. **I hereby confirm my consent to participate in this study.**

Check all that apply.

☐ Yes ☐ No

Demographic Information

2. **What's your age group?**

Mark only one oval.

- ☐ 18 & Below
☐ 20-29
☐ 30-39
☐ 40-49
☐ 50 and above

3. **What's your gender?**

Mark only one oval.

☐ Male ☐ Female

4. **Years of Experience in Clinical nutrition:**

Mark only one oval.

- ☐ 0-5 Years
☐ 6–10 years
☐ 11–15 years
☐ 16 years and above

5. **Region of Practice**

Mark only one oval.

- ☐ Nairobi ☐ Central ☐ Coast ☐ Rift Valley ☐ Western
☐ North Eastern ☐ Eastern
☐ Nyanza Region

Current Use of the Food Exchange List

6. **How often do you use the Kenyan Food Exchange List (KFEL) for meal planning?**

Mark only one oval.

- ☐ Always ☐ Frequently
☐ Occasionally ☐ Never

7. **In your experience, how accurate is the KFEL when used for meal planning?**

Mark only one oval.

1 2 3 4 5

Inaccurate ☐ ☐ ☐ ☐ ☐ Highly accurate

8. **What are the main challenges you face when using the KFEL for meal planning? (*Select all that apply*)**

Check all that apply.

- ☐ Inconsistent portion sizes
☐ Time-consuming calculations
☐ Inaccurate food group classifications
☐ Lack of detailed information (e.g., nutrient values) ☐ Limited food options relevant to local cuisine

Other: ☐ _____

Evaluation of Household Servings vs. Metric Measures

9. **Do you find consistency between the household measures and metric measures in the KFEL?**

Mark only one oval.

☐ Yes ☐ No ☐ Maybe

10. **How would you rate the consistency between the household measures and metric measures in the KFEL?**

Mark only one oval.

1 2 3 4 5
☐ ☐ ☐ ☒ ☐
Inconsistent **ent** Very consistent

Feasibility and Usability of the Diet Wizard Application Prototype

11. **How user-friendly did you find the Diet Wizard application for meal planning?**

Mark only one oval.

- ☐ Very easy to use
☐ Easy to use
☐ Somewhat difficult
☐ Very difficult

12. **How would you rate the application's ability to reduce the time required to create meal plans compared to the manual process?**

Mark only one oval.

☐ Significantly reduced ☐ Moderately reduced ☐ No difference
☐ Increased

13. **Did the application improve the accuracy of your meal plans?**

Mark only one oval.

☐ Yes, significantly ☐ Yes, moderately ☐ No improvement ☐ Decreased accuracy

14. **What challenges did you encounter when using the Diet Wizard application? (Select all that apply)**

Check all that apply.

- ☐ Technical difficulties
☐ Inaccurate portion calculation ☐ Limited food options
Other: ☐ _____

Impact on Professional Practice

15. **Do you believe that the Diet Wizard application could enhance patient care through improved meal planning?**

Mark only one oval.

- ☐ Strongly agree
☐ Agree
☐ Neutral
☐ Disagree
☐ Strongly disagree

16. **How likely are you to adopt the Diet Wizard application as part of your daily practice if fully developed and integrated?**

Check all that apply.

- ☐ Very likely
☐ Somewhat likely
☐ Unlikely
☐ Very unlikely

17. **What features would you suggest adding to improve the Diet Wizard application?**

End of Questionnaire

Thank you for your time and participation!

APPENDIX IV: Factors considered in meal plan generation process

Activity factor

Activity		Activity factor
Bed immobile	and	1.0-1.2
Out of bed		1.3-2.0

Contribution of macronutrients to total calories

nutrient	percentage
carbohydrates	55%
protein	15%
fat	30%

Contribution of macronutrients in g of calories

nutrient	g	kcal
carbohydrates	1	4
proteins	1	4
fat	1	4

Quick factor method

physical activity	overweight	normal weight	underweight
sedentary	20-25 kcal/kg	30 kcal/kg	35kcal/kg
moderate	20-25 kcal/kg	35 kcal/kg	40kcal/kg
active	20- 25kcal/kg	40 kcals/kg	45kcal/kg

Stress factor in clinical situation

Clinical situation	Stress factor
Starvation	0.85
Elective surgery	1.05-1.15
Sepsis	1.20-1.40
Head injury	1.3
Trauma	1.4
Inflammation	1.5
Burns	2

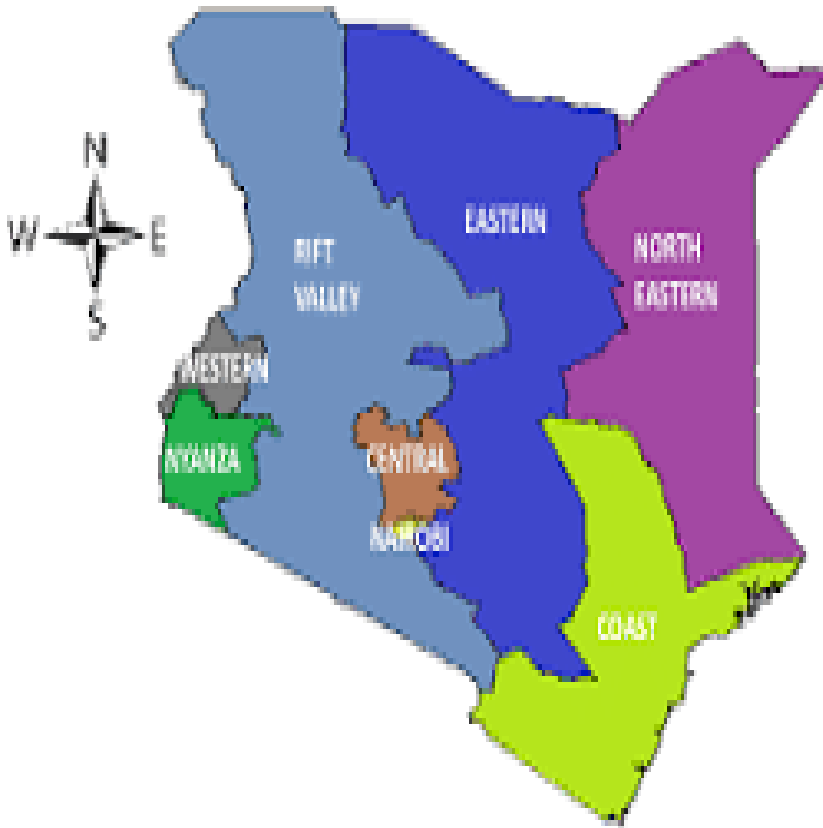
APPENDIX V: Guideline for identifying the size of a sample for a certain population

N	S	N	S	N	S	N	S	N	S
10	10	100	80	280	162	800	260	2800	338
15	14	110	86	290	165	850	265	3000	341
20	19	120	92	300	169	900	269	3500	246
25	24	130	97	320	175	950	274	4000	351
30	28	140	103	340	181	1000	278	4500	351
35	32	150	108	360	186	1100	285	5000	357
40	36	160	113	380	181	1200	291	6000	361
45	40	180	118	400	196	1300	297	7000	364
50	44	190	123	420	201	1400	302	8000	367
55	48	200	127	440	205	1500	306	9000	368
60	52	210	132	460	210	1600	310	10000	373
65	56	220	136	480	214	1700	313	15000	375
70	59	230	140	500	217	1800	317	20000	377
75	63	240	144	550	225	1900	320	30000	379
80	66	250	148	600	234	2000	322	40000	380
85	70	260	152	650	242	2200	327	50000	381
90	73	270	155	700	248	2400	331	75000	382
95	76	270	159	750	256	2600	335	100000	384

Note: "N" is population size
"S" is sample size.

Source: Krejcie & Morgan, 1970

APPENDIX VI Map of Kenya showing the regions in Kenya



APPENDIX VII NACOSTI letter of clearance

 REPUBLIC OF KENYA	 NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY & INNOVATION
Ref No: 356727	Date of Issue: 03/February/2023
RESEARCH LICENSE	
	
This is to Certify that Miss.. CATHERINE AYIENDA OMWOYO of Kenya Methodist University, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Baringo, Bomet, Bungoma, Busia, Elgeyo-Marakwet, Embu, Garissa, Homabay, Isiolo, Kajiado, Kakamega, Kericho, Kiambu, Kilifi, Kirinyaga, Kisii, Kisumu, Kitui, Kwale, Laikipia, Lamu, Machakos, Makueni, Mandera, Marsabit, Meru, Migori, Mombasa, Muranga, Nairobi, Nakuru, Nandi, Narok, Nyamira, Nyandarua, Nyeri, Samburu, Siaya, Taita-Taveta, Tanariver, Tharaka-Nithi, Transnzoia, Turkana, Uasin-Gishu, Vihiga, Wajir, Westpokot on the topic: EVALUATION AND AUTOMATION OF THE KENYAN FOOD EXCHANGE LIST FOR DIET PLANNING AMONG MOH EMPLOYED DIETITIANS IN KENYA. for the period ending : 03/February/2024.	
License No: NACOSTI/P/23/22999	
356727 Applicant Identification Number	 Director General NATIONAL COMMISSION FOR SCIENCE, TECHNOLOGY & INNOVATION
	Verification QR Code 
NOTE: This is a computer generated License. To verify the authenticity of this document, Scan the QR Code using QR scanner application.	

APPENDIX VIII Ethical clearance letter from kemu



KENYA METHODIST UNIVERSITY

P. O. BOX 267 MERU - 60200, KENYA
TEL: 254-064-30301/31229/30367/31171

FAX: 254-64-30162
EMAIL: INFO@KEMU.AC.KE

December 13, 2022

Commission Secretary,
National Commission for Science, Technology and Innovations,
P.O. Box 30623-00100
NAIROBI.

Dear Sir/Madam,

RE: Omwoyo Catherine (REG. NO. HND-3-1672-1/2021)

This is to confirm that the above named is a bona fide student of Kenya Methodist University, in the School of Medicine and Health Sciences, of Department of Public Health, Nutrition and Dietetics undertaking a Masters' Degree in Public Health. She is conducting research on: "Evaluation And Automation Of The Kenya Food Exchange List For Diet Planning Among MOH Employed Dietitians In Kenya" We confirm that her research proposal has been presented and approved by the University.

In this regard, we are requesting your office to issue a research license to enable her collect data.

Any assistance accorded to her will be appreciated.

Thank you.



Dr. John Muchiri, Ph.D.

Director, Postgraduate Studies

Cc: Dean SMHS
CoD, PHND
Postgraduate Co-ordinator-PHND
Supervisors

APPENDIX IX Nairobi county authorization letter

NAIROBI CITY COUNTY

Telegraphic Address
Email: info@nairobi.go.ke
Web: nairobi.go.ke



CITY HALL ANNEXE:
P.O. BOX 30298 GPO – 00100.
NAIROBI, KENYA

TALENT, SKILLS DEVELOPMENT & CARE SECTOR

Ref: GL/NC/141/VOL VII/44

10th March, 2023

Ms. Catherine Ayienda Omwoyo
Kenya Methodist University
P.O. Box 00500
NAIROBI, KENYA

RE: RESEARCH AUTHORIZATION

Following your application to carry out Research and Subsequent approval by National Commission for Science, Technology and Innovation vide letter Ref: NACOSTI/P/23/22999 dated 3rd February 2023;

I am pleased to inform you that authority has been granted to you to carry out research on *EVALUATION AND AUTOMATION OF THE KENYAN FOOD EXCHANGE LIST FOR DIET PLANNING AMONG MOH EMPLOYED DIETITIANS IN KENYA* for the period ending 3rd February 2024.

On conclusion of the study, you are expected to submit a copy of the research findings to the undersigned:

Susan Mutemi



SUSAN MUTEMI

FOR: ASST. DIRECTOR TEACHER MANAGEMENT & PARTNERSHIP

Copy to:

- CECM – Talent, Skills Development & Care
- County Chief Officer – ECD & Vocational Training
- Director City Education

"Let's Make Nairobi Work"