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Artificial Neural Network Algorithm in Nutritional Assessment: Implication for Machine Learning Prediction in Nutritional Assessments in Strict Veganism

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Abstract

A considerable number of published research has indicated that evaluating the success of weight-loss therapy involves proper dietary examination. On the other hand, the bulk of dietary evaluation methods currently in use have favored manual memory recall. In the current study, we used an artificial neural network (ANN) machine learning algorithm to construct an artificial intelligence-based nutritional assessment system. The algorithm used information from a user's regular meals as well as their preexisting health indicators to formulate a machine based nutritional assessment requirement. ANN-based nutritional evaluation approaches will make it possible to assess eating habits, recommend daily meals, and improve general health. In particular, we develop a machine learning technique to identify multiple food items by classifying them using an ANN machine algorithm and identifying suitable nutritional assessments using anthropometric, biochemical, clinical, and dietary (ABCD) data. Using an ANN machine learning model, the artificial intelligence system initially creates a number of proposals from the input. Next, using information from the unique ABCD nutritional evaluation, it creates feature maps for each proposal and used the ANN machine learning algorithm to classify diet interval and its composition. Lastly, using the UK-based Dietary Reference Values (DRVs) ranges as a basis, we examined the user's nutritional evaluation obtained from the system. The results of the experiment shown that our system can reliably identify food items and quickly provide nutritional assessment reports, which will give users a clear understanding of practical and healthy eating recommendations in a strictly vegan diet.

Keyword: Artificial Neural Network (ANN), Health Management, Health Improvement, Nutritional Assessments, Vegan Diets, Weight-Loss Therapy

1. Introduction

The public health policy and administration has been able to move from treatment and diagnosis into prevention and wellness due to a recent paradigm shift in healthcare management that gives disease surveillance a higher priority(Organization, 2023). Because of this, people are

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now living longer and are in better general health. Maintaining a good health requires a completely eradication of any tendency to disease, which implies finding ways to stop disease agents from spreading or building resistance to illnesses (Organization, 2018). On this note, adults in the US that make up over one-third (34.9%) or 78.6 million population are obese, while over 17% (or 12.7 million) of adolescents and teens are overweight(Liu et al., 2017). Global estimates for overweight adults over the age of 18 in 2014 put the number at 1.5 billion(Chu et al., 2018). A framework for food consumption and nutritional assessment needs to be developed in order to control obesity and weight loss therapy.

Nonetheless, the existing techniques for evaluating diet, such as 24-hour dietary recall and food frequency surveys that depend on memory to recall consumed meals, are incredibly inefficient(Coelho-Júnior, Calvani, Landi, Picca, & Marzetti, 2021). The primary cause of obesity and overweight is an energy imbalance between calories taken and calories spent, according to the World Health Organization (WHO), which also defined obesity as an abnormal or excessive fat accumulation that may hinder healthy living(Mohajan & Mohajan, 2023). The obesity epidemic has been escalating globally, and as of now, no nation has been able to stop the alarming trend because of inadequate technological solutions that tackled the issue from all angles. In terms of the global population, nearly 1.9 billion adults were overweight in 2016(Pourfarzi, Sadjadi, Poustchi, & Amani, 2022). Among the most common causes of avoidable, early death are obesity-related disorders such as heart disease, stroke, type 2 diabetes, and several forms of cancer(De Lorenzo et al., 2020). There is a wide range of potential causes for obesity, of all the factors, an individual's diet and manner of consumption determine their behavior, which in turn affects how much weight they gain(Mauldin, May, & Clifford, 2022). By calculating the energy intake, which comprises calories as well as other dietary components like fat, carbohydrates, and protein, individual can assess whether or not they are following a healthy diet.

To maintain a healthy lifestyle, it will be more important than ever to precisely estimate the number of calories in food. Nutrient-based advice can be challenging for consumers to follow since foods are more than just collections of nutrients. Dietary recommendations based on food were consequently developed by national and international health promotion organizations that supported evidence from epidemiological and clinical research, that there is correlation between specific dietary patterns and decreased risks of specific diseases(Barrea et al., 2024). To accurately determine the kind and origin of nutrition-related health concerns that impact a person, nutritional assessment is a methodical process that involves data gathering and analysis(Malik, Narayanasamy, Pratyusha, Thakur, & Sinha, 2023). A thorough examination and trustworthy interpretation are made possible by the conventional "ABCD" systematic approach, which includes anthropometric, biochemical, clinical, and dietetic examinations(González-Salazar et al., 2023). Maintaining health and safeguarding key organ function requires appropriate nutritional and metabolic modifications for clinical illness management. With the appropriate nutritional therapy and the patient's starting nutritional state, the substrate required to fulfill the rising metabolic demand will be provided. Minimize catabolism, start an immune response, and improve overall health when the body's metabolic needs are met during an infection. Evaluating nutritional status in-depth is required before selecting the appropriate type of metabolic support. How successfully

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the initial diagnostic and technical adjustments are performed largely determines the outcome of food therapy. The danger of developing clinical issues is raised when synchronized malnutrition is linked to insufficient nutritional intake and nutritional composition.

Here, we outline two main research initiatives that aim to create cutting-edge algorithms for nutritional recommendations. A novel food classifier that uses an ANN machine learning algorithm to improve the nutritional requirements for strict veganism is one of these efforts. The second research effort aimed to develop a real-time meal suggestion or recommendation system for dietary evaluation based on strict vegetarianism. Comprehensive trials were also carried out using real-world data. Our data demonstrate that nutritional assessment domains had really outstanding results from our strategy. When compared to all previous published data, our proposed model produced the most accurate nutritional evaluation results, as far as we could determine. Second, the response of the suggested system satisfies the bare minimum of the methods already in use. This research work is structured into introduction, objective of the study, review of the literature, research design, and research methodology, data analysis, discussion of the research findings, recommendation and conclusion.

2. Objectives of the Study

i. To provide users with a clear knowledge of practical and healthy eating recommendations in a purely vegan diet, we developed a dependable ANN-based system that might be used to recognize meal combination and swiftly produce nutritional assessment results.

ii. To propose an algorithmic system base on ANN that use information from a user's regular meals as well as their preexisting health indicators to provide nutritional evaluation that will make it possible to assess eating habits, recommend daily meals, and improve general health.

iii. To address some of the issues with the conventional 24-hour dietary recall and food frequency surveys that rely on recalling details from memory, a novel AI-based nutritional evaluation algorithmic system is being developed in order to attain the best-in-class dietary accuracy in a strictly vegan diet.

iv. To build a body of knowledge on the evaluation of diet-related diseases, disseminate research in this regard, and apply findings to dietary management strategies.

3. Literature Review

Maintaining weight loss without compromising vital nutritional needs that could impact life and important human organs like the kidney, liver, and heart requires precisely computing user-centric nutritional intake using a high-quality food record(Liu et al., 2017). By working with nutritionists and dieticians to map out a portion of a sustainable nutritional composition, this would enable more precise body mass index (BMI) calculations and diet planning. In order to give users more individualized food advice, the system might be enhanced by working with nutritionists and dieticians. Incorporating further user inputs such as food preferences, allergies, and medical history may be necessary in accomplishing this purpose. Regrettably, there are still many social,

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technological, and economic obstacles that need to be overcome before it can be possible to increase the daily rationalization of food intake accuracy(Al-Mssallem et al., 2024). Notwithstanding the broad standards for nutritional evaluation, obesity, diabetes, and associated cardiometabolic issues are becoming more prevalent due to modern diets and lifestyle modifications. They might have had an impact on the rise in cancer and other non-metabolic disorders like inflammatory bowel disease. Population-based diets don't work, mostly because of their unpredictable nature, undesirable side effects, and challenges in sustaining long-term adherence. A person's eating habits and the things they eat can have a variety of effects on their health and illnesses. Nutrients have a direct effect on circadian rhythms, metabolic pathways, nutritive metabolism, and epigenetic processes(Mahmoud, 2022).

Foods can influence immunological, senescence, endocrine, and neurological responses indirectly(Wu, Gao, Yu, & Wang, 2022). A combination of dietary factors can both accelerate the onset of disease and improve clinical results by reactivating altered pathways that promote resistance to disease. This is the way that numerous nutritional interventions have proven to be useful in human clinical studies. For individuals with metabolic problems, calorie restriction lowers blood pressure and body weight. A lower risk of atherosclerosis and cardiovascular events is linked to eating a Mediterranean diet. In a similar vein, a ketogenic diet has been linked to better respiratory outcomes in those with lung illness and can help avoid the occurrence of epilepsy(McDonald & Cervenka, 2018). The effectiveness of immune checkpoint inhibitors has improved recently in cancer patients who use prebiotic supplements. Sadly, despite these encouraging instances, the bulk of diets' efficacy has not been sufficiently evaluated or validated in many groups, and many of the underlying mechanisms relating to possible bioactivity are still unknown. Moreover, even in same clinical or physical environments, different people may experience different results from identical diets. In a nutshell, a variety of factors, such as genetic diversity, shifts in ethnicity, culture, and lifestyle, and associated modifications to the gut microbiome, the community of microorganisms that coexist on human mucosal surfaces, especially the gastrointestinal tract, can affect how variable these effects are.

It can be inferred from this that the microbiome, which is influenced by age, gender, medication use, meal timing, and composition, may be responsible for the inter-individual heterogeneity in food responses. Coming up with dietary suggestions that would work for everyone becomes challenging when these factors are taken into account. Disregard for gender disparities, ethnic differences, reporting biases, adherence, short-term triumphs followed by long-term failures, and a lack of control and transparency can all be linked to the relative lack of long-term efficacy of dietary regimens. Actually, when several well-followed dietary suggestions don't work over time, people become frustrated and try to figure out what to eat by trial and error, which may involve following dubious or non-evidence-based advice. Excessive consumption of non-caloric food additives with lower calorie content can cause blood glucose levels to unexpectedly rise when trying to control diabetes and lose weight(Cohen, Valdés-Mas, & Elinav, 2023). Dietary studies frequently fail to identify some of these negative effects because of insufficient data collection, a

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lack of long-term follow-up, or an inability to contact dropouts who may suffer these negative consequences.

The exponential growth in scientific, technical, and medical attempts to improve the collection and analysis of vast volumes of data on individuals and their unique responses to nutrition was sparked by these major issues ten years ago(Nazir et al., 2020). In this case, generating recipes with ChatGPT can also result in more customization. Recipes that are customized for certain dietary requirements, culinary abilities, and food tastes can be created with ChatGPT's assistance. This enables more customized meal planning and can result in more fulfilling meals for people regardless of the range of dietary needs. The food sector is using ChatGPT, a big language model created by OpenAI, to enhance recipe development. Through the use of a technique known as sequence generation, ChatGPT is able to produce language that is human-like(Matthew, Bakare, Ebong, Ndukwu, & Nwanakwaugwu, 2023), which allows it to create a library of substitute ingredients and assist with customized meal planning(Ayinde, Wibowo, Ravuri, & Emdad, 2023). The computer-aided solutions that enable the shift from hospital-centered and reactive healthcare to preventative, proactive, evidence-based, and person-centered healthcare are strongly linked to the recent advancements in extreme digital automation, introducing ChatGPT into its central discussion. These solutions can also be applied to improve diet evaluation accuracy. The inherent relationship between a person's diet and their body's processes has led to a great deal of interest in the field of nutritional assessment from both academic and industrial sources(Martínez-González, Gea, & Ruiz-Canela, 2019). Because of this, we made the decision to present an AI systematic technique as a fresh strategy that will help to fix the dietary dilemma.

4. Artificial Intelligence Based Evaluation of Food and Nutrient Consumption

An individual's food and nutrient consumption can be evaluated using the internationally recognized techniques of a 24-hour recall of food intake, food diary, and three-day food weighment survey. These approaches are laborious and call for qualified individuals to conduct patient interviews and gather data. Their main source of information is the subject's recollection. Therefore, there is very little chance of the data being accurate, particularly if the person is old or suffering from conditions like dementia or Alzheimer's disease that might impair memory. Given that adequate nutrition preserves wellbeing and reduces the functional decline brought on by aging and disease conditions, providing appropriate nutrition and assessing real food and nutrient intake present challenges in these situations. When designing and evaluating therapeutic menus for patients receiving medical care, precise and dependable data on food and nutrient intake is crucial. It has been noted in previous research that inaccurate estimation of food consumption data may introduce bias into the trustworthiness of data collected using conventional approaches. Furthermore, there's no proof in the data regarding the menu's veracity or authenticity. The solution came from (Subhi, Ali, & Mohammed, 2019), using a vision-based technology to identify the foods and portions eaten. Food recognition and portion estimate were developed using the vision

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recognition approach previously, which was implemented in certain mobile phone user interfaces using face recognized images as the main datasets(Tahir & Loo, 2021).

They were standardized and validated by similar sets of photos of various fast food items intended for consumer consumption. Datasets with pictures of food components were used to standardize recipes. Using appropriate automated analytical tools and statistical and mathematical methods, the optimal choice for process technology or ingredient can be made. The implementation of webcams above plate placement is necessary for the creation of an AI-based nutritional assessment system for patients and the elderly in those designs. The system evaluated the image in three stages: segmentation, recognition, and piece size estimation. In **Figure 1**, the operation of ANN nutritional assessment for food and nutrient intake is diagrammatically represented.

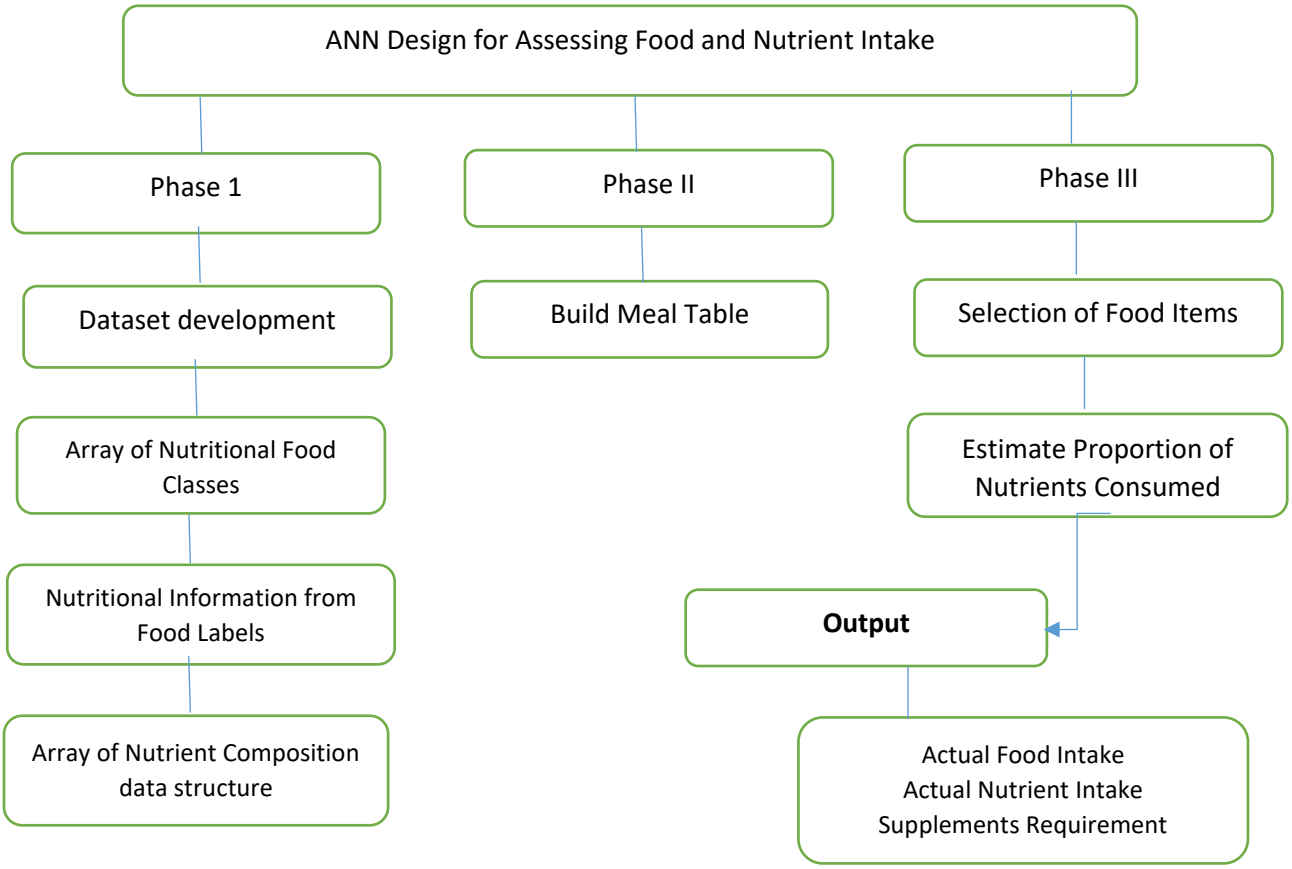

Figure 1: An information-processing flow diagram of ANN Food and Nutrient intake

In the current design, to facilitate meal analysis, the standard input is divided into segments, such as (Breakfast, Lunch, Dinner, In-between meals), through a process known as segmentation. The design build an array of food items and food classes and divides the nutritional information into several groups during the categorization phase. In order to detect the classified food, the system creates data structure around them in a table format which help in meal extraction. More

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precise food and nutrient intake data as well as accurate dietary assessments may result in healthier diets and improved clinical outcomes. When it comes to providing nutritional care to people who suffer from obesity and other diet-related non-communicable diseases, this is especially crucial. When food and nutrient consumption are carefully evaluated, glycemic and lipidemic management can be achieved in these circumstances. Inaccuracies in the measurement and ingestion of carbohydrates may have an impact on insulin dosage fixing. In addition, managing immune-compromised illnesses requires accurate nutrition data. The nutritional analysis of the meal is made possible by algorithms created based on datasets such as segmentation of the food and ingredients, nutrition facts from product labels, and databases of nutrient composition(Sudersanadas, 2021). Figure 1 shows the structural depiction of how AI is used to determine nutritional intake.

A nutrient estimation method that is both highly accurate and fully automated requires the combined efforts of experienced nutritionists and a reliable, customized food and nutrient database. The development and commercialization of these smartphone-based applications can now take place across a wide range of categories, mostly due to technology developments. Malnutrition has a cascading influence on health outcomes, increasing the incidence of hospital-acquired infections, prolonged hospital stays, morbidity, and mortality among other consequences. Enough food and nutrient intake are necessary to maintain nutritional status and promote early healing. Malnutrition may occur during a patient's hospital stay if they arrive at the hospital already malnourished. Reduction in food and nutrient intake because of anorexia is the main cause of hospital-acquired malnutrition. Inaccurate evaluations of food and nutritional intake can occasionally lead to patients developing malnutrition. The hospital offers various ways for measuring food and nutrients, including digital photography, visual assessments, and food weighment. However, these methods might be laborious or prone to mistakes, which can lead to significant adjustments in the patient's diet. Furthermore, the effectiveness of these techniques is diminished for patients who are kept apart. In order to collect data without coming into contact with the patient or the patient's trays, an ANN-based food and nutritional intake assessment internet of thing (IoT) device or platform can be integrated to overcome these obstacles via remote access.

5. Research Design

A critical analysis of the data in the scientific literature on nutritional assessment, together with evidence-based dietary recommendations and a thorough evaluation of the case study participant (Mrs. Rita) were all included in the current study. Based on these findings, conclusions were reached. Applying an understanding of anthropometric approaches and procedures that was acquired during in-depth hands-on training, a case study participant was assessed for nutritional status, and the results were presented in an understandable manner. In accordance with professional practice guidelines, we created an evidence-based treatment plan after thoroughly analyzing the data and comparing it to the UK dietary reference values (DRVs) on nutritional assessment. The research is a case base study involving a 32-year-old Mrs. Rita, a school teacher, who is married to Mr. Ben and has a 6-year-old daughter. At the age of twelve, Mrs. Rita adopted a vegan lifestyle. Although her busy schedule prevents her from cooking, she wants to eat a

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diversified diet. Sweets are her thing, and she loves to nibble. To get her daughter to school, Mrs. Rita walks around two miles every day. The doctor suggested that she lose weight in order to aid with her back pain when she was seeing him for a recent episode of it. He recommended that she exercise frequently and maintain a healthy diet. Mrs. Rita made the decision to get guidance on how to make dietary improvements.

On Mrs. Rita's family history, her parents are obese, but neither Type 2 diabetes nor heart disease run in her family. She has one or two glasses of wine a day and doesn't smoke. The 24-hour dietary recall that we obtained from Mrs. Rita is shown here in **Table 1**.

Table 1: 24 Hours Dietary Recall for Mrs. Rita

Breakfast (7:30am) A single vegan sausage roll One medium-sized almond-milk latte (Starbucks) + (2 table spoon of sugar)
Snack (10.30 am) Tesco's spiced nut mixture (45g) A single tea cup (no milk, 2 table spoon of sugar)
Lunch (1.30 pm) One cooked cup of white rice, 180g of stir-fried vegetables, and 80g of tofu A single vegan carrot cake slice
Snack (4 pm) One tiny pack (25g) of Walkers Crips
Dinner (6:30 pm) One Vegan steak bake (Quorn) Sixteen chips One table spoon of vegan mayonnaise One table spoon of tomato ketchup Two medium glasses of red wine
Evening snack (8 pm) One medium apple A handful of plant-based marshmallows

Table 2: Anthropometric data collected for Mrs. Rita:

Parameter	**Result**
Physical Body Weight	**88Kg**
Tallness	**171cm**
Circumference of the Waist	**93cm**
Circumference of the Hip	**108cm**
Percentage of the Body Fat	**39%**

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Body mass index (BMI) (kg/m2) is a simple and easily accessible anthropometric test to diagnose obesity in clinical procedures, particularly when BMI ≥30 kg/m2(Al-Ghamdi et al., 2018). It has been discovered that the BMI is a useful tool for estimating the population's risk of health issues(Boutari & Mantzoros, 2022). It has been demonstrated to have a sensitivity of 53% and specificity of 99% for identifying obesity in women in the 30- to 39-year-old age range(Nonsa-Ard et al., 2022). Nevertheless, there are several disadvantages, such as the challenge of differentiating between the distribution of body fat and lean muscle mass. based on the industry-standard measurements as per the BMI guidelines of the World Health Organization (WHO)(Stewart, Ledingham, & Williams, 2017). Based on Table 1, Mrs. Rita is categorized as obese, Class I. Type 2 diabetes, digestive, respiratory, and cardiovascular diseases are all become more likely by obesity. According to (Dikaiou et al., 2021) and (Luca et al., 2023), adults who are overweight or obese have an exponentially increased risk of acquiring hypertension and atherosclerosis, which puts Mrs. Rita at risk for serious health problems.

The Waist circumference (WC) is a reliable measure of abdominal fat, is a better predictor of the risk of Type 2 diabetes, cardiovascular disease, and other metabolic issues(Hewage, Wijesekara, & Perera, 2023). This useful metric has positive correlations with the risk of stroke, hypertension, and non-alcoholic fatty acid disease; a BMI evaluation can be utilized to bolster these findings. Present guidelines suggest that women should strive for waist circumferences of ≤80 cm, since those with waist circumferences more than 88 cm are markedly more likely to experience cardiometabolic issues(Nussbaumerova & Rosolova, 2023). Waist circumference and insulin resistance are related to the precursors of type 2 diabetes(Al-Sulaiti et al., 2018). Given that Mrs. Rita's BMI and WC are greater than suggested, she has a heightened risk of acquiring the previously described ailments. The waist to hip ratio recommended by current guidelines is ≤0.85cm for health, which increases Mrs. Rita's risk of metabolic diseases.

Table 3: Mrs. Rita Biochemical data

Biomedical Specification	Result
Fasting blood glucose (mmol/l)	**5**
Hemoglobin (HbA1C %)	**4**
Whole-body cholesterol (mmol/l)	**5.9**
LDL cholesterol (mmol/l)	**3.6**
HDL cholesterol (mmol/l)	**0.8**
Triglyceride (mmol/l)	**2.3**
Haemoglobin (g/L)	**106**
Haematocrit (L/L)	**0.33**

Table 4: Observable Biochemical Data for Mrs. Rita

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Parameter(X1)	Result(X2)	Clinically Recommendable Level(X3)	Clinical/Health Consequences (X4)
Fasting blood glucose (mmol/l)	5	Between 3.9 and 5.6 mmol/L are appropriate(Yu et al., 2022).	Mrs. Rita A fasting blood glucose level of 5 mmol/L is considered normal.
Hemoglobin (HbA1C %)	4	< 5.7% (Borai et al., 2024).	Hemoglobin (HbA1C%) for Mrs. Rita is normal at 4 compared to the clinically appropriate level of less than 5.7.
Whole-body cholesterol (mmol/l)	5.9	5.17 mmol/L	The cholesterol level throughout her body is normal for Mrs. Rita. If the total cholesterol level was 6.21 mmol/L or higher, it might have been deemed elevated(Murdock, Sanchez, Mohammadi, Fazio, & Geba, 2023).
LDL cholesterol (mmol/l)	3.6	3.4 mmol/L to 5.2 mmol/L	When compared to the clinically recommended range of 3.4 mmol/L to 5.2 mmol/L, Mrs. Rita's low-density lipoprotein cholesterol level is Normal(Ji, Xia, Cao, & Zou, 2016).
Triglyceride (mmol/l)	2.4	< (1.69 mmol/L)	The triglyceride level of Mrs. Rita is higher—2.4 mmol/L—than what is required—less than 1.69 mmol/L(Khan et al., 2017).
Haemoglobin (g/L)	106	Women(0.36L/L to 0.48 L/L)	When compared to the 0.36L/L to 0.48L/L recommended for women, Mrs. Rita's hemoglobin level of 0.31L/L is marginally lower(Schapkaitz, RabuRabu, & Engelbrecht, 2019).
Haematocrit (L/L)	0.32	The Haematocrit for women is between 0.36L/L and 0.48 L/L.	In comparison to the suggested range of 0.36L/L to 0.48L/L for women, Mrs. Rita's hemoglobin level of 0.31L/L is marginally lower(Moses, Umanka, Mary-Jane, Ogbonnaya, & James, 2018).

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6. Methodology used in Constructing the ANN-based Nutritional Assessment System

The authors presented ANN architecture in this section, which was influenced by the structure of the human brain. The human brain is made up of a complex, highly linked network of neurons that electrically communicate with one another to help process information(Gebicke-Haerter, 2023). Similarly, software programs or algorithms that are employed in computing systems to carry out mathematical computations, logic, inductive, and deductive reasoning are composed of artificial neurons that work together to solve problems(Booker, Chiu, Groff, & Richardson, 2024). Artificial neurons are software modules, also known as nodes that allows computers to learn from very large datasets by providing them with intrinsic access to them. In order to make wise decisions, machine learning software looks for patterns in the data that already exists and applies those patterns to fresh data. In order to learn, neural networks first process a number of sizable sets of labeled or unlabeled data and offer meaningful insight through algorithmic synthesis. In this instance, the ANN algorithm is nothing more than a methodical process used to complete a task unique to data mining. The generalized ANN algorithmic flowchart, depicted in **Figure 2**, includes the following step-by-step process for completing data mining tasks:

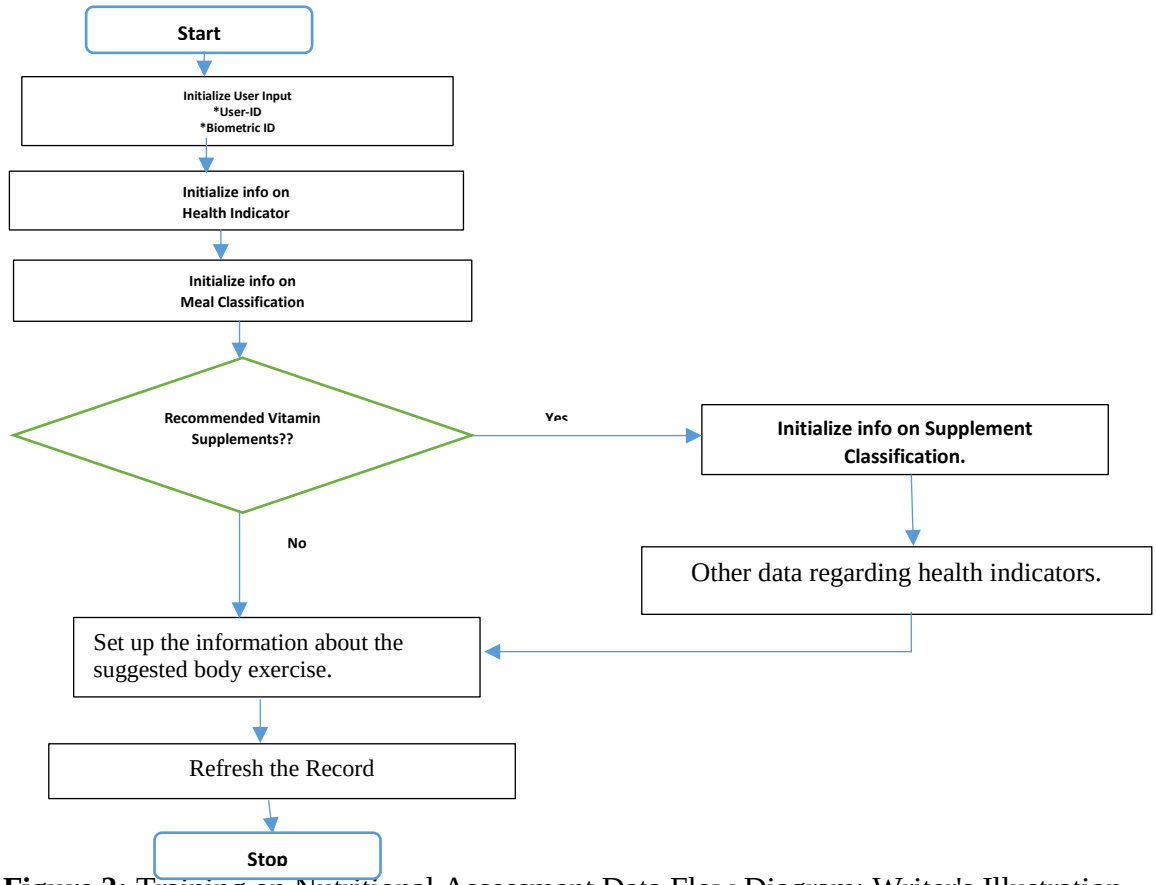

Figure 2: Training on Nutritional Assessment Data Flow Diagram: Writer's Illustration

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The data platform streamlines and automates the workflow of dieticians, nutritionists, nutritional assessors, and doctors, resulting in fewer errors, faster approval processes, and uniform data processing. Healthcare and Nutritional Organizations can save time and effort on decision-making by integrating ANN base data mining into their data frameworks(Nwanakwaugwu, Matthew, Kazaure, & Haruna, 2023). When it comes to language models, generative artificial intelligence and ChatGPT in particular offers a remarkable technological achievement as a game-changing tool for natural language processing(NLP) and as a revolutionary tool for nutritional assessment in healthcare, which is the subject of ongoing research. This work expanded on the prospective uses of generative AI for NLP synthesis and its potential role as a conversational agent in nutritional assessment. Thanks to its capacity to understand and generate language that is human-like by using NLP to develop semantics, generative AI was able to replicate the most advanced human technology with detailed assumptions of patterns and structures it learns from its training data. On this note, the proposed approach has was tested on two difficult data sets, and the results show that our system has met its goals, which include developing a real-time system with a response time that is nearly the fastest among current methods and outperforming all previous approaches in terms of clinical condition prediction using standard reference values.

When it comes to patient dietary assessment, predictive models provide the best informational support and knowledge available to nutrition specialists. Predictive nutritional data mining in health management aims to construct a predictive model that is understandable, generates dependable forecasts, and assists medical professionals in diagnosing patients and formulating treatment plans. Biomedical signal processing is an important application of ANN base nutritional data mining. It communicates through internal guidelines and reactions to improve the condition when the relationship between various subsystems is unknown and when traditional analysis methods are ineffective, as is frequently the case with nonlinear associations.

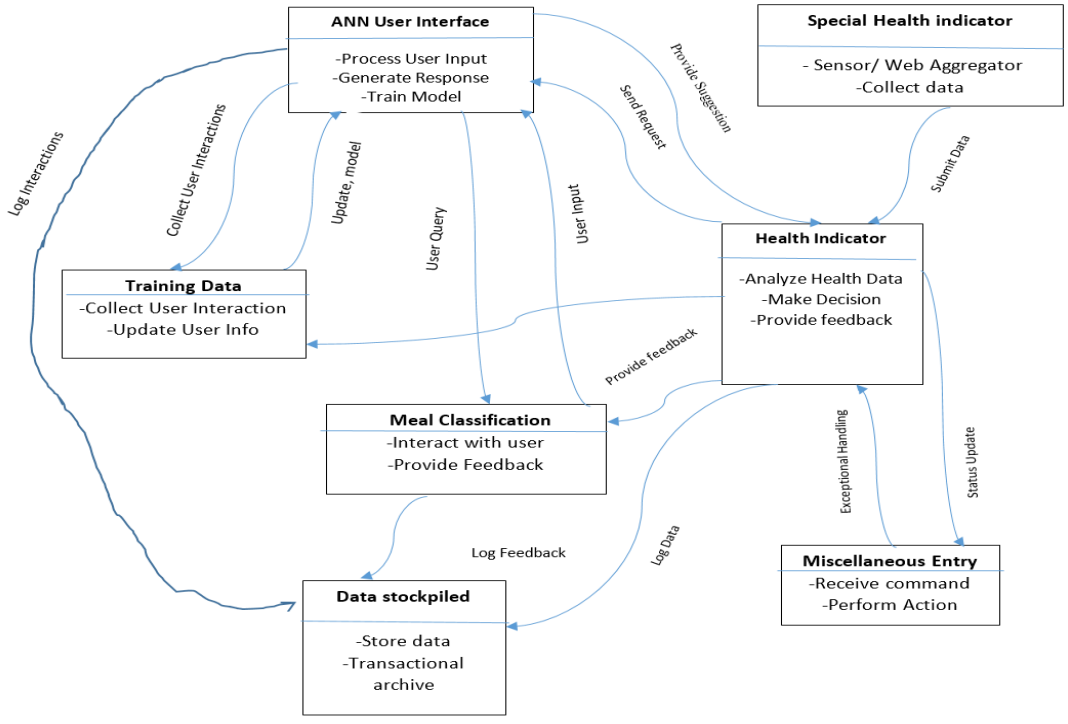

Figure 3: Architecture for Implementing ANN Interface for Nutritional Assessment: Authors Illustration

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The generalized ANN training technique needed for nutritional assessment data mining operations is summed up in Figure 3: For the first consumable component, items that were both food and drink were combined and compacted into thirty food groups; for the second, identical nutrient profiles were found in twenty food groups (Table 5), closely matching a previously published research work(Gallagher, Hanley, & Lane, 2022). Utilizing two-factor cluster analysis, which first performs pre-clustering and then uses hierarchical techniques to identify groups, allows for the automatic determination of the number of clusters. The twenty food categories were arranged in a dendrogram using two-factor cluster analysis, with samples with low correlations being far separated from food groups with the greatest correlations. Specifically, the two food groups that showed the strongest association were found and combined into a single synthetic sample. Next, the highest association between the other food groups and the synthetic sample was found. After repeating this method until every sample was combined into a single sample, the correlations between the samples were represented as a hierarchical tree(Borràs et al., 2015). Variations in the amount of vegan food and beverages consumed were observed in the dietary patterns. Following the explanations found in the literature, the clusters were labelled according to the kinds of inputs that represented each component.

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Table 5: Vegan Foods and dietary types that were part of the nutritional assessment cohort's analysis(Gallagher et al., 2022).

Food groups 1	Food groups 2 (variables)	Definition and content
1. Legumes & nuts 2. Meat alternatives	1. Protein alternatives to meat & fish	Soya, Tempeh, Tofu, silken tofu, lentils, pulses, nuts, falafel
3. Meat-free processed alternatives 4. Fish alternatives	2. Processed meat alternatives	Vegan nuggets, burgers, bacon, sausage, no fish fingers, ham slices, turkey slices, chicken slices, meat-free mince, vegan chorizo
5. Vegan sandwiches 6. Vegan wraps 7. Ready-prepared foods	3. Convenience meals & snacks	Garlic bread, pizza, sausage rolls, chips, ready prepared mash, selection of pre-made vegan sandwiches & wraps, ready meals, Not-zarrella sticks, French fries
8. Fresh fruit 9. Tinned fruit 10. Dried fruit	4. Fruit	Apples, pears, oranges, grapefruit, bananas, grapes, melon, peaches, strawberries, avocado, tinned fruit, dried fruit
11. Vegetables 12. Soup	5. Vegetables	Carrots, spinach, broccoli, Brussel sprouts, cabbage, peas, green beans, courgettes, cauliflower, parsnips, leeks, onions, garlic, mushrooms, sweet peppers, beansprouts, green salad, mixed vegetables, watercress, tomatoes, sweetcorn, beet-root, coleslaw, vegetable soup, rainbow rice
13. Starchy carbohydrates	6. Refined grains	White bread, scones, crackers, pitta, sugary cereal, plain cer-eal, white rice, pasta, tinned pasta, noodles, lasagne, cereals (except high fibre options)
14. High-fibre carbohydrates	7. Wholegrains	Brown bread, wholemeal bread, porridge, all bran, wholegrain cereals, brown rice, wholemeal pasta, wild rice
15. White potatoes 16. Sweet potatoes	8. Potatoes	Boiled potatoes, roast potatoes, sweet potatoes, home-made mash, baked potatoes, baby potatoes
17. Plant-based milks 18. Vegan cheese 19. Vegan yoghurts	9. Dairy alternatives	Oat milk, soya milk, almond milk, rice milk, hazelnut milk, coco-nut milk hemp, pea milk, Nutritional yeast, vegan hard cheese, Yoghurt alternatives,
20. Fats and oils	10. Fats and oils	Vegan butter spreads, pesto, peanut butter, olive oil, sunflower oil, coconut oil, avocado oil, canola oil, sunflower ghee, rape-seed oil, fry light
21. Cakes & biscuits	11. Vegan cakes & biscuits	Cookies, Digestive twists, bourbons, Lotus Biscoff, vegan sponge cake, vegan cereal bars, party ring minis, granola bars
22. Sweets and desserts	12. Vegan sweets & desserts	Fudge, cheesecake pots, chocolate mousse pots, dark choco-late, non-dairy ice cream, churros, star burst sweets
23. Vegan crisps	13. Vegan crisps	Lentil Chips, Kettle chips, walkers, tortilla chips, vegetable chips, pretzel bites
24. Sauces & condiments	14. Sauces and condiments	BBQ sauce, cheese sauce, Red lasagne sauce, free from sauce, olive oil, vegetable oils, seeds, tahini, vegetable pates, mayonnaise, hummus, chocolate spread, coleslaw, potato salad
25. Salt	15. Salt	All added salts
26. Alcohol	16. Alcohol	Vegan friendly alcohols
27. Vegan takeaway	17. Vegan takeaway	From fast-food outlets providing vegan options
28. Cooking	18. Cooking from scratch	Additional question to help with establishing vegan patterns
29. Recipes used	19. Creating own recipes	Additional question to help with establishing vegan patterns
30. Use of vegan brands	20. Purchasing vegan brands	Additional question to help with establishing vegan patterns

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7. Discussion of Findings

Due to her low levels of high-density lipoprotein (HDL) cholesterol (0.9 mmol/L) compared to the clinically acceptable range of 1.55 mmol/L, Mrs. Rita has an atherogenic lipid profile, which increases her risk of developing ischemic coronary heart disease (CHD)(Kalyani, Everett, Perreault, & Michos, 2023), for a detailed account of Mrs. Rita's biochemical assessment, please see table 4. Based on the data in Table 3, which is the basis for the biochemical nutritional assessment of Mrs. Rita, her fasting blood glucose concentration level of 5 mmol/L is considered normal(Zhang, Zhao, Yang, & Zhang, 2019). It is advised to monitor glucose levels and make lifestyle modifications if fasting blood glucose readings fall between 5.66.9 mmol/L and 6.9 mmol/L in order to prevent diabetic ketoacidosis (Association, 2023). Mrs. Rita will have hypoglycemia, or low fasting blood glucose, if her blood glucose level is less than 3.9 mmol/L(La Sala & Pontiroli, 2021). Palpitations, perspiration, lightheadedness, blurred vision, and other symptoms are possible with this illness and should be carefully watched for. For Mrs. Rita The clinically acceptable level of less than 5.7% is considered normal; the hemoglobin (HbA1C%) is 5. A1C less than 5.7%, however, is considered normal. Prediabetes is defined as having an A1C of 5.7% to 6.4%; diabetes is defined as having an A1C of 6.5% or higher. Mrs Rita at 5.8 mmol/L, the total cholesterol level is normal. At 6.21 mmol/L or higher, the total cholesterol level might have been deemed high. People with high blood cholesterol have an increased risk of developing coronary heart disease. Though typically regarded as advantageous, low total cholesterol and low low-density lipoprotein cholesterol have occasionally been connected to specific health problems. When compared to the therapeutically recommended range of 3.4 mmol/L to 5.2 mmol/L, the Rita low-density lipoprotein cholesterol level is normal.

Atherosclerosis is the primary cause of heart attacks, strokes, peripheral artery disease, and other cardiovascular events brought on by high concentrations of low-density lipoprotein (LDL) cholesterol. In comparison to the appropriate HDL cholesterol level of 1.03 mmol/L, Mrs. Rita's HDL cholesterol of 0.9 mmol/L is low. A low HDL count is concerning since it is linked to an increased risk of heart disease. This is also applicable in the event that Mrs. Rita's LDL cholesterol is elevated. High levels of LDL and HDL raise her risk of having a heart attack or stroke. The 2.4 mmol/L of triglycerides in Mrs. Rita's blood is higher than the 1.69 mmol/L required. According to (van de Woestijne et al., 2013), there is a correlation between a low level of triglycerides (TG) and a high level of high-density lipoprotein cholesterol (HDL-C)—TG ≥1.60 mmol/L [≥142 mg/dL] and HDL-C ≤1.18 mmol/L [≤46 mg/dL]—and a higher risk of ischemic heart disease (IHD). On the other hand, a low-TG–high HDL-C level—TG ≤1.09 [≤97 mg/dL] and HDL-C ≥1.48 mmol/L [≥57 mg/dL]—is associated with a decreased risk. It may be inferred from the given data that Mrs. Rita has a high concentration of triglycerides (2.4 mmol/L), which puts her at risk for ischemic heart disease. Compared to the 121g/L to 151g/L recommended for women, Mrs. Rita's hemoglobin level of 105g/L is lower. This implies that symptoms of low hemoglobin levels include headaches, tiredness, a fast heartbeat, and pale skin. Medical experts may employ iron therapy or other therapies using iron supplements to address low hemoglobin. Mrs. Rita's hemoglobin level of 0.31 L/L is marginally lower than the 0.36 L/L to 0.48 L/L range that is advised for women.

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8. Conclusion

The goal of this work was to create a useful ANN-based nutritional assessment within the framework of artificial intelligence computing. Creating a body of information on the assessment of diet-related disorders, sharing research in this area, and implementing findings to dietary management strategies was the main technique innovation in this study. Our proposed approach has been tested on two difficult data sets, and the results show that our system has met its goals, which include developing a real-time system with a response time that is nearly the fastest among current methods and outperforming all previous approaches in terms of clinical condition prediction using standard reference values. Maintaining health and safeguarding key organ function requires appropriate nutritional and metabolic modifications for clinical illness management. With the appropriate nutritional therapy and the patient's starting nutritional state, the substrate required to fulfill the rising metabolic demand will be provided. And last, a well-planned vegan diet must include adequate amounts of calories, nutrients, and necessary supplements, such as vitamin B12, vitamin D, and omega-3 fatty acid. Eating fortified foods can reduce the risk of vitamin deficiencies in adults, such as Mrs. Rita and the general population. Before committing to a vegan diet, it is strongly advised that vegans consult physicians or nutritionists for medical advice. Since our study pertains to the biological domain, significantly larger data sets are required to furnish compelling proof for validating the usefulness and efficiency of our suggested approach, notwithstanding.

9. Conflict of Interest

There is no conflict of interest regarding this work, the research work was supported by U&J Digital Consult Limited , an IT and Educational Consult Firm base in Nigeria.

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