

## Development of Models by Energy Expended and Age Classifications for Diet Recommendation System

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**ABSTRACT:** *People today are more conscious of their health and constantly looking for methods to improve their health status. Due to the unavailability and inaccessibility of dietitians to recommend diet, people do not know how to plan their diet well, thereby people's health are compromised because of unbalanced diet and misappropriation of diet. There is need to develop models that recommend diet on various classifications on the basis of energy expended daily and age. The models are mathematically represented using arithmetic expressions on different classifications: Energy expended or job/activities, health status, family size and age. The models use the rule-based statements to proffer solution to diet problems. In employing the technology, the models were implemented using a programming tool like PhP etc The DRS can be deployed on the World Wide Web and be allowed to be used by the general public for a healthy diet. The Diet Recommendation System (DRS) creates and increases people's awareness and assist them in receiving appropriate counsel as to the quantity of food, food types, time to take food, the appropriate food for certain age group, the balanced diet for a family size, the kind of food type according to the activities a person engages in.*

**Keywords:** recommendation system, dietitian, models, food classification

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### INTRODUCTION

Health is important in life. Good health depends on the right nutrition or diet. When body absorbs sufficient amount of nutrients in meal, then there is long-term growth, development and health. Being alive requires balanced food that sustains the body, thereby giving room to the body cells to survive. When food or meals contains nutritious values, then one is less prone to develop health issues later in life.

Diet recommendation system (DRS) is a system that recommends the food to be eaten in terms of quantities, food types and time of the day to take the meal so that body will benefit from it for growth, development and sustainability. If one eats healthily, diseases will be far away from the body, thereby body would enjoy stability, growth and development.

Meals taken three times of the day are called breakfast, lunch and dinner respectively. The three categories of meal taken in a day are described as: The first meal of the day is called breakfast. It is typically taken in the early morning before starting the day's work. It is regarded by some as the most significant meal of the day. Literally, the term "breakfast" refers to ending the previous night's period of fasting. A simple meal commonly eaten at midday is referred to as a luncheon or lunch. Typically, lunch comes after breakfast as the second meal of the day. The term "dinner" is the meal taken at the evening time. It is usually taken after lunch. It is not a must to take three times of meal in a day especially when adulthood is approaching. In adulthood, dinner may be taken early enough to give room to the intestine to move on time as expected. Breakfast is as well good to be taken everyday in order to allow the body to perform its activities.

Using a diet recommendation system provides proper meal planning. The results to the provision of all nutrients in required amounts and proportions yields balanced diet (Wansink, 2010; WHO, 2012). The family's well-being and health are depended on how well they are fed based on energy expended/activities done or age. It assesses each potential meal types in light of the user's dietary objectives. The types of food to take at a age group is being considered by the DRS.

The DRS has capability to recommend the type of food at a time; to create awareness of time to eat the food in a day and help in consuming right amounts of nutrients in food; to plan out how many portions of each food group to consume and on which diet; to allow eating habits are less prone to veer off course; and has the ability to quickly alter your meal strategy in order to know the quantities of meal beneficial to the body.

Diet Recommendation System (DRS) is an automated systems that uses the models to allow the users to enter inputs on the basis of factors, analyze and generate result intelligently (Douglas et. al., 2014; Fisher and Yoo, 1993). The system generates a diet recommendation report to aid users in their day to day meal for a healthy life. The objective of the study is to develop models for diet recommendation system.

## **LITERATURE REVIEW**

There are so many studies on diet planning and the adoption of technology to build up ways to plan meal. There are systems which also suggest diet regimens, aid users in altering their eating habits as western civilization may cause unhealthy eating which is becoming a bigger issue for people of all ages. It frequently results in a decline in living quality and health issues, which in turn raises the cost of already overburdened health care systems.

The application that did a work of diet consultant was developed by Jasud et al (2023). The diet plan that needed to give some information to the dietician such as its body type, weight, height and its working hour details are mentioned. The system also provided the diet plan according to the information entered by the user. The system asked some data from the user and processed it to provide the diet plan to the user. Thus the user did not need to visit any dietician, thereby it saved time and the user could get the required diet plan at a click.

The study described the creating process of a project called Nutritious, a website platform that offers diet consulting services with nutritionists, healthy food catering, and purchasing fresh ingredients (Utami, 2022)

In their review of automated menu planning approaches, Nazia et al. (2014) noted that planning is widely employed when it comes to menu. Planning is a critical component of rational conduct, according to theory. Their study discussed the development of menu planning; the most recent advances in nutrition care expert systems. A theoretical framework for a system for menu planning and recipe design was described by Douglas et al. (2014). This system built a developed AI system for problem solving that largely relies on categorization.

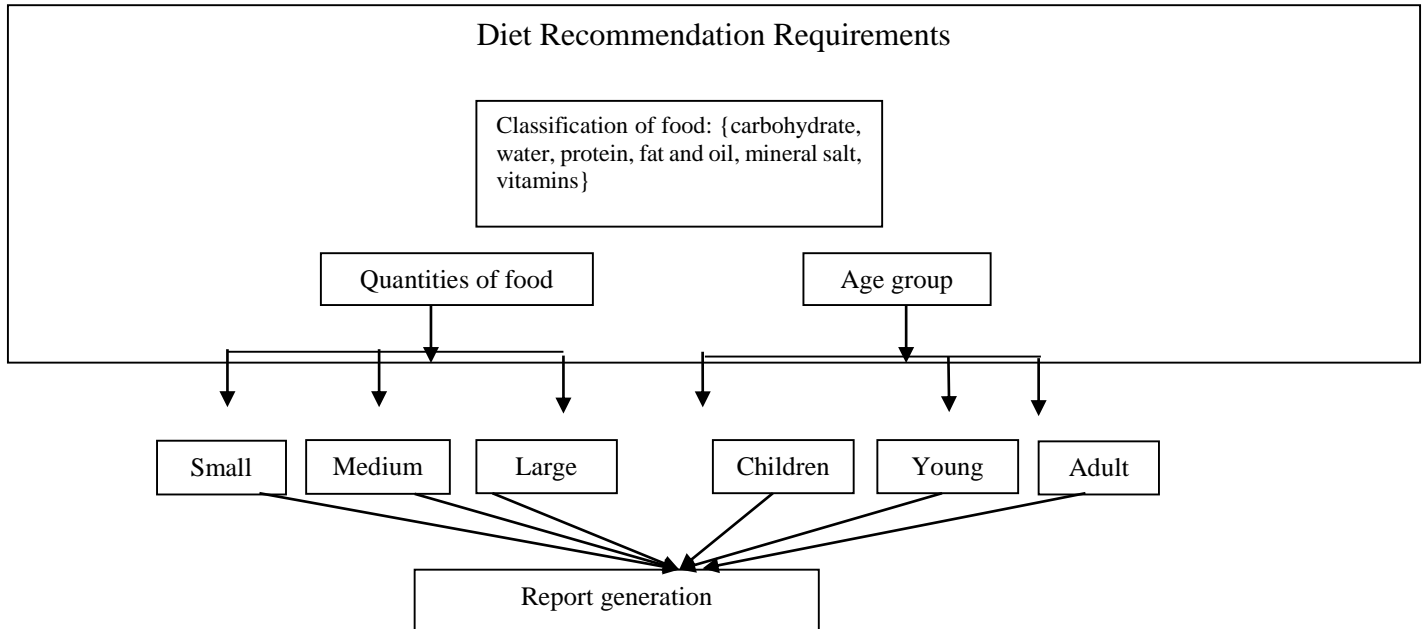
In the study of an evaluation of a diet planning system by Johan (2017) noted that unhealthy eating is a growing issue in western civilization. The study offered a diet planning system that makes suggestions for appropriate meal recipes while taking crucial considerations like nutrient content, affordability, variation, etc. into account. Through settings, a user can regulate how the system takes these aspects into account before the system generates an ideal diet plan. After that, the user can tweak the variables again until a successful diet plan is generated.

## **METHODOLOGY**

The development of a Diet Recommendation Model (DRM) is a form of meal planning system that can be used by dieticians to prescribe a list of food ingredients in preparation of food for a group of family, patients in hospitals or individuals on the basis of activities being done or age of individuals.

DRS is based on the food nutrients or food ingredients with daily activity level. It also intends to assist to meet the individuals' and families' specific goals and body needs. The system can also be used to prescribe the quantity of food, time to eat, the food for age group, the food types. All these, the proposed system help in order to keeps body fit. The dietary recommendation system can improve awareness towards healthy lifestyle among people.

The proposed architecture for diet recommendation system is demonstrated in Figure 1 which consists of various processing components as follows:



**Figure 1: Diet Recommendation System (DRS)**

**COMPONENTS OF THE DIET RECOMMENDATION SYSTEM**

The diet recommendation system architecture has components which recommend the appropriate and quantities of meals to be taken at a time of the day for individual/individuals so that there will be provision of all nutrients being required in a right proportion to make a healthy life.

The components are diet recommendation requirements, diet recommender and report generation. The Diet Recommendation Requirements consist of quantities of food and age. Quantities of food is divided into large, medium and small quantities. The age group is split into adult, young and children. The components are described in the requirements below.

**REQUIREMENTS OF THE DIET RECOMMENDATION SYSTEM**

The requirements of the diet recommendation system consist of food types or classification of food.

a. **Food types:** Food types/classification are the classifications of food which are protein, carbohydrates, water, fat and oil, mineral salts, vitamins as described below:

i. A calorie is a unit of measurement that describes how much energy is released when body breaks down food. Most carbohydrates contain in high calories. The ranges of calories needed by a woman are grouped into Not physically active - 1600 calories; moderately active -1800; active lifestyle – 2,000-2,200. A man needs calories of these ranges: Not physically active – 2000-2,200

calories; moderately active -2,200- 2,400; active lifestyle – 2,400-2,600 calories (National Institute on Aging, 2022).

ii. Protein provides nutrients important for maintaining health and body. They are from seafood; meat, poultry, and eggs; beans, peas, and lentils; and nuts, seeds, and soy products etc. The amount of protein foods you need depends on the age, sex, height, weight, and physical activity.

iii. Fats and oils can be derived from plants, land or marine animals. Oils are commonly obtained from oil producing plants like corn, peanuts, soya beans, vegetable seeds, olives, palm kernels, whilst fats are more commonly obtained from animal sources like milk (butter), beef (tallow), pork (lard), etc. Fats and oils can also be obtained from marine sources like fish (Centre for food safety, 2018)

iv. Vitamins are organic compounds that are needed in small quantities in the body. They maintain health, bodily function; they fight infection, wound healing etc. Vitamins can be obtained from fruits, vegetables, whole grains and cereals, lean meats and reduced fat dairy products. They are about 13 vitamins: A, B, C D, E. F etc

v. Mineral salt is the family of salts that can be obtained by mining i.e. below the ground surface. They can be obtained from vegetables, plants, fruits. The natural mineral salts are sodium, phosphorus, potassium,, chlorine, sulphur and calcium while the micro elements in the minerals salts are iodine, iron, fluoride and zinc.

vi. Water is an inorganic compound that constitutes hydrogen and oxygen. It is a transparent, tasteless, odorless, and colorless chemical substance. It helps in temperature regulation, digestion, lubrication, boosting skin health, transportation of nutrients and oxygen to cells, elimination of waste products from cells, maintaining healthy blood pressure and balancing of the body's electrolytes.

b. **Quantities of food:** This shows the amount of food to be taken by the individual. It also indicates how much of a food you are served or how much you eat. In this study, it is grouped into small, medium and large

c. **Age group:** An age group is the people in a place or organization who were born during a particular period of time. (Collins Dictionary, 2023) in this study age group here is categorised into children from age 0-16; young is from age 17-40 and Adult is from age 40 and above

## MODEL REPRESENTATIONS OF DIET RECOMMENDATION SYSTEM

The models of the Diet Recommendation System (DRS) are described in classifications on the basis of:

1. *Energy expended or activities being done by individuals*: The type of activities or job or work an individual does, determine the kind of food to take at a particular time of the day.
2. *Age*: The kinds of food types and quantities of food to be taken depend on the age.

i. Food classification is represented by equations 1 and 2.

Food classification/types (Fc) = carbohydrate (c) (calories/sugar/glucose) + water (w) + protein (p) + fat and oil (fo) + mineral salt (ms) + vitamins (v)

$$Fc = (c + w + p + fo + ms + v) \text{ in appropriate proportions} \quad \text{Equation (1)}$$

$$Fc = \sum_1^n fc \text{ in appropriate proportions}$$

$$Fc = fc_1^n \quad \text{Equation (2)}$$

Where n is the number of food types that ranges from 1 to n

ii. Quantities of food an individual takes is categorised into small, medium and large as represented below:

Quantities of food (Qf) = (Small, Medium, Large)

a. Age Group (Ag) = (Children, Young, Adult)

Age group is categorised into children, young and adult

There is a relationship between Quantities of food (Qf) and Age Group (Ag)

Quantities of food (Qf)  $\propto$  Age Group (Ag)

Qf  $\propto$  Ag (small, young, adult)

Qf  $\propto$  Ag

Qf = KAg

$$K = Qf/Ag \quad \text{Equation (3)}$$

Where K is the constant between Qf and Ag,

Qf is the quantities of food, Ag is the age group.

There is a relationship between Food quantities (Qf) and food classification /type (Fc). It is represented as follows:

Qf  $\propto$  Fc

Qf (small/medium/large)  $\propto$  Fc

Qf (small/medium/large)  $\propto$  Fc<sup>n</sup>

Qf (small/medium/large) = Z Fc<sup>n</sup>

$$Z = Qf_{(small/medium/large)} / Fc_1^n \quad \text{Equation (4)}$$

Where Z is the constant between Qf and Fc

## CLASSIFICATION BY ENERGY EXPENDED/ACTIVITIES/WORKDONE

Diet recommendation system can be classified by the energy expended or activities or work-done by an individual. The kind of work or activities an individual does determine the kind of diet or meal to be taken. If an individual does a heavy task job, such individual needs meals in high calories.

A model can be derived from the above equations (1-4) based on the kind of work or job or energy expended by an individual. The work/job is considered in two forms: High or Low (i.e if the work an individual does, requires a lot of energy or low energy). These are presented as follows:

$$Work/job (High) = (fc_1^n)_{\text{in high proportions}} * K * T_{\text{(breakfast/lunch/dinner)}} \quad \text{Equation (5)}$$

$$Work/job (Low) = (fc_1^n)_{\text{in low proportions}} * K * T_{\text{(breakfast/lunch/dinner)}} \quad \text{Equation (6)}$$

where K has the relationship between the Age group (Ag) and food quantities (Qf)<sub>(medium/large)</sub>

Equation (5) expresses when the nature of job or work being done requires much energy, then food classification or types should be in high proportion in respect to medium or large food quantities according to age group and Time to take the food in the morning, afternoon and dinner.

In a situation, where the work done or job done requires less energy, then the food type should be in low proportion in respect to less or small quantities of food according to the age group and time to take the food as seen in Equation (6).

## CLASSIFICATION FOR AGE (ADULTS, CHILDREN AND YOUNG)

A classification of diet recommendation model is by age. The classification is for the adults. Due to the age and body structure of adults, their bowels or intestines may not move as expected. Hence, the DRS is derived as follows in equation (7):

$$Age (Adult) = (fc_1^n)_{\text{right proportion}} \text{ wrt } T_{\text{(breakfast/lunch/no dinner/light food)}} * \text{ wrt } Qf_{\text{(small/medium/not large)}} \quad \text{Equation (7)}$$

In equation (7), an adult takes meal in a right proportion which has to be in the morning and afternoon, but if dinner exceeds normal time in the evening, it should be skipped or light food should be taken instead.

There is another equation (8) for the adults, where high fat and oil, calories, sodium, sugar, carbohydrate should be avoided from meal or diet.

$$Age (Adult) = (fc_1^n)_{\text{right proportion}} - fc_{\text{high (fat/oil/calories/sodium/sugar/carbohydrate)}} \quad \text{Equation (8)}$$

The children and the young are hyperactive, hence their bowels move easily. Equation (9) is for the children and the young, It is stated as follows:



$$Age (children/young) = (fc_1^n)_{\text{right proportion wrt T (breakfast/lunch/light food)}} * \text{wrt Qf (small/medium)}$$

Equation (9)

The right proportion of food to be taken by the children and the young should be small or medium according to age for the breakfast, lunch and for the dinner, it should be light food.

## RESULT AND DISCUSSION

The development of diet recommendation model can be a web based for recommending meal in the right proportion in terms of age and the how much work an individual engages in. The system assists people by providing the guidance for decision making as to the quantity of food to take; the food types to take in the right proportion and at what age group an individual should take the quantity of food. The system is helpful in terms of types of food to take and the quantity of food.

If an individual does work that requires high energy, the person should take food types with high calories in the high proportion in the morning and afternoon. This has to be done according to the age group. An individual of a sedentary life or individual whose work requires low energy, such person should not take food in high calories; and quantities of food to take should be small or medium.

The diet recommendation model is classified based on age group. When an individual is an adult, right proportion of food types should be taken. Such an adult should not take large quantities of food that is rich in fat and oil, sodium and calories. The time to take dinner should be early at evening time. Late dinner with large quantity of food should not be taken. The child or the young could take his meal in small or medium quantity according to the age.

Programming tools can be used to implement the proposed system. PHP with others tools were employed to implement and the following interfaces in Figure 2 and 3 are presented.

Figure 2 enables the master administrator to load the system with the requirements alongside with their corresponding nutrients such as fat, protein, carbohydrate, vitamin, mineral salt, water etc. It gives room for adding foods types and displaying them. Figure 3 specifies the food to eat in the day. Recipes can be added by the user.



The screenshot shows a web application interface for adding recipe contents. On the left is a dark sidebar with a user profile for 'admin' (Online) and a search bar. Below the search bar is 'MAIN NAVIGATION' with links for 'Dashboard', 'Recipess' (with a notification badge '1'), and 'Control' (with a notification badge '1'). The main content area is titled 'Home - Meal Planning' and contains a form with the following fields:

- Code:** Code
- Recipes Name in English:** Recipes Name in English
- Energy (kg):** Energy (kg)
- Water (kg):** Water
- Protein (kg):** Protein
- Fat (kg):** Fat
- Carbonhydrate (kg):** Carbonhydrate
- Fibre (kg):** Fibre
- Ash (kg):** Ash
- Recipe Best For:** Choose Recipe State (dropdown menu)

A blue button labeled 'Add Recipes Contents' is located at the bottom right of the form. At the bottom of the page, there is a watermark for 'Activate Windows' and the text 'Copyright © 2019 All rights reserved.' and 'Version 1.0'.

Figure 2: Food classification

The screenshot shows a web application interface titled 'Meal Planning System' with the heading 'Add Your Favourite Recipes To Make Up Your Weekly Meal Plan'. It features a table with the following columns: Recipes, Calories, Protein, Carbonhydrate, Fat, Energy, Fiber, Ash, Suitable For, and Action. The table lists four recipes with their respective nutritional values and suitable times. Each row has a '+' button in the Action column.

Recipes	Calories	Protein	Carbonhydrate	Fat	Energy	Fiber	Ash	Suitable For	Action
Amala served with Draw Soup plus roasted Fish	345	7	50	13	12	1.2	1.1	Dinner	+
Beaf served with Tea	161.6	18.2	0.6	9.6	12	1.2	3.6	Drink	+
Beef Roll	374	12	50	14	12	1.3	1.9	Lunch	+
Chicken with Chinchin	148.9	20.5	2.1	6.5	12	3.6	1.2	Drink	+

At the top of the table, there is a dropdown menu for '10 records per page' and a search bar. Below the table, there is a note: 'Please ensure you add enough food before your [Generate Your Weekly Meal Plan](#). You can view [Your Recipe](#)'.

Figure 3: Food types and time

## CONCLUSION

People these days like to be more aware of their health; they are always searching for ways to help them to be healthier. The use of model can recommend food quantity individuals can take so that people can get proper meal planning and adds value to people life.

It provides a wide range of recommendations for the amount of nutrients such as proteins, vitamins, mineral salts, carbohydrates, fat and oils that the body requires to function properly. Additionally, the model aids users in deciding whether to take a light dinner or skip a dinner especially when an individual is heavy. The model also provides quantity of food to be taken by an individual. It also considers the level of calories an individual should take when it comes to huge activities or job an individual does. The models are mathematically represented and can be implemented using any programming tools to make it interactive so that the users can maximally benefit from it and appropriate recommendations could be made in the area of the quantity of food to be taken and age.

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