



# Design of Personalized Diet and Physical Activities Recommendation Framework for Hypothyroid Patients

Vaishali S Vairale, Samiksha Shukla

**Abstract:** *These days, hypothyroid disease is quickly growing among individuals. In India, one out of eight women experiences hypothyroid disorder because of iodine deficiency. It is necessary to maintain the thyroid hormone levels because it may lead to thyroid cancer. There is a need to consume an adequate amount of iodine intake and other nutrients required to balance thyroid hormones levels. So, patients should follow a customized daily diet and exercise plan to meet their nutritional needs. These recommendations help hypothyroid patients to enhance their metabolism and to adjust thyroid hormones levels. Most of the existing online systems usually provide diet recommendations in general forms. Such recommendations are insufficient for any patient suffering from a specific disease. This paper provides a personalized recommendation framework to provide appropriate diet plans and physical activities to patients. These recommendations are based on their clinical data and personal choices. Validation of recommendations can be made by combining both domains like human expertise and computer technologies.*

**Keywords:** *Personalized, Recommendation framework, Diet and physical activities, Hypothyroid disorder.*

## I. INTRODUCTION

Nowadays, individuals rely upon the web for searching any type of data. They make use of web crawlers like Google, Yahoo, etc. to search information related to their queries. Sometimes, they cannot get the exact information related to individual's medical problems. Many related articles are available on the web. However, individuals find difficulty in extracting important data effectively as per requirement. Also, every person is having different likes and dislikes. So, to search appropriate diet and physical exercise plans becomes a bit difficult for individuals. Also, patients may have few health issues. So, some food items and physical activities are not suited for them. Online recommender frameworks for diet and physical activities help a person to find healthy food choices by analyzing their profiles [1,2,4]. Food

recommender applications help the patients to maintain their food intake with adequate amount of nutrients [3]. It also recommends the suitable diet and physical activities plans as per patient's clinical data and preferences.

Diet and physical activities suggestions are found more generic. These recommendations are not appropriate for an extensive variety of customers. The diet and physical recommendation may differ from one individual to others. The recommendation can be made based on distinctive age groups, gender, weight and height ratio, daily lifestyle, food habits and activity levels. As diet and physical activities are firmly co-related. Modification in food intake will help to regulate the metabolism in hypothyroidism [15]. Diet and physical activities recommendations include knowledge bases from different areas. These areas are like personal profile, intake of food, physical activities and disease history. The proposed customized diet and exercise recommender framework enables the patients to follow healthy food habits.

### A. Overview of Hypothyroidism

The thyroid organ is a butterfly-like shaped endocrine gland. It is in neck's lower front part of human body. The main functionality of thyroid organ is to secrete thyroid hormones like T4-thyroxine and T3-triiodothyronine. It releases these hormones into blood stream. These hormones control the metabolic rate of human's body and growth. Mal-functioning in the thyroid organ causes thyroid disorders. Hypothyroidism causes due to low secretion of thyroid hormones. Abnormally higher value of TSH leads to hypothyroidism. So, thyroid gland releases more T4. Lack of adequate amount of these hormones may lead to slow down patient's metabolism [25]. Weight gain is the main risk associated the hypothyroid patients. Apart from this, there is a risk of cardiovascular diseases also. There is a strong connection found between thyroid diseases, glucose levels, and diabetes. It is good to have a better knowledge of metabolic changes related with thyroid disorder. Individuals with hypothyroidism may suffer from undesired weight gain. It is difficult to reduce weight till stabilization of hormonal levels [26]. During this period, it is needed for hypothyroid patients to follow healthy lifestyle. They can switch to eat nutritious foods and to exercise regularly [32].

### B. Impact of Diet and Physical activities on Hypothyroidism

Dietary nutrients are an integral part in synthesizing of thyroid hormones. There are many key nutritional factors requires to consume to balance thyroid functions. Iodine deficiency is one of the causes of hypothyroidism.

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Individuals need enough iodine to avoid the mal functioning of thyroid gland. There are other nutrients like zinc, selenium, vitamin B12, vitamin D, etc. are required to balance the hormonal levels [29, 30, 31]. So, the patients are advisable to consume a balanced diet with healthy food items to meet their daily iodine requirement. They need to eliminate the most goitrogenic food items from their diet. Hypothyroidism reduces energy levels. So, regular physical activities can improve thyroid functionality. It also improves the physical activeness of hypothyroid patient [27,28].

It is required to suggest balanced diet with right food items, essential nutrients and with right quantity. Along with these, right exercises with intensity and duration are needed to achieve the right hormonal balance and healthier body [16]. So, there is a requirement of diet and exercise recommendation framework to assess specific nutritional needs of individuals. It also gives relevant information regarding food and exercise with consideration of their health problems. It enhances person's health by analyzing different data sources like food items & their nutritional values, physical activities, personal profile and health history.

## II. RELATED APPROACHES

Many research studies have a great impact of their work on dietary and exercise in healthcare domain. Studies discussed that unhealthy eating food habits and irregular exercise routines are contributing as major risk factors in many chronic disorders. Absence of regular exercise and unhealthy food intake may lead to unhealthy lifestyle. Previous studies suggested various methods to develop food recommender systems. They considered food ontologies for diabetic patients [17], clustering techniques like SOM (Self Organizing Map) and K-Means algorithm [18], RBR (Rule Based Reasoning) and CBR (Case Based Reasoning) for cancer patients [19], Type-2 Fuzzy Logic for chronic diseases [20], genetic algorithm [21].

A knowledge-based recommendation framework is constructed for food recommendations. Constrained optimization methods were used for diet planning [5]. Adoption of easy meal plans by people were suggested in this study [6]. A few studies suggested systems which had depended on meal preparation procedures. These meal plans were extracted from available data online as per the needed calories [7]. The diet recommender framework used fuzzy logic systems to analyze uncertainty or fuzziness of valued provided by user [8, 9].

Some of the current works are discussed in this paper for diet and physical activities recommendations [10]. The recommendation system analyzed and coordinated personal data, diabetes issue, and food data. Fuzzy inference was analyzed to generate recommendations. The study didn't consider on time glucose level. The recommendations for physical activities are generic to all, which can be done by considering individual's activity level preferences. The work [11] focused on recommending permitted, not permitted, and suggested food items by analyzing individual's demographic and medical data. It needed to consider client's preferences for food and exercise. It didn't provide the amount of consumption of food items for the individual.

The study developed a system [12] which enabled medical expert to make better decision by following dietary guidelines. It helped patients to do a follow up of their dietary and exercise data on weekly basis. The study didn't focus on user choices, their cultures and health issues. An application named SHADE is developed [13] which produced diet with food lists with portion size as per users' preferences. It also suggested individual's which exercises had to performed with duration and intensity.

The framework [14] constructed a client's health profile. It provided diet suggestions according to the patients' profile. This study suffered from cold-start problem and needed to include regular food items. Interactive participation of medical experts is required for validation of generated recommendations. A diet recommendation framework for chronic kidney disorder has been developed [22]. It considered current health condition of patient and amount of food intake. It needs to generate specific diet for patients to follow daily. Recipe ontology-based recommendation framework is developed to provide diet to individuals based on their health conditions and preferences [23]. Individualized diet plans are not generated.

Fuzzy-based ontology technique is used for diet recommendations which considered Ayurveda and prakriti. Each individual has his/her own prakriti and may different from one another. Disease domain is missing in this work. Also, the quantity of nutrients and impact of them on diet based on individual' prakriti has not been clearly interpreted [24].

Various frameworks for diet suggestions exist for patients with diabetes, yet none of these systems have considered the mix of the distinctive knowledge bases, integrated into one framework. The knowledge bases for disease, food and exercise have their own constraints, complexities and specific working standards. These all knowledge bases are strongly related for diet and physical activities suggestions for patients [15].

## III. METHODOLOGY

The system analyses the requirements of the critical nutrients in the diet for hypothyroid patients. These needed nutrients are prioritized as per their importance with each other. Based on these nutrients and preferences, alternative diet and physical activities plans are generated by the framework. These generated plans are then validated by medical experts.

### A. Proposed Framework

The objective of this research work is to design a personalized recommender framework. It provides a personalized nutrition expert system which considers user preferences of foods and exercises. A framework considers the level of disease which is effective in maintaining thyroid hormone levels. Several studies in past have worked with several health issues and recommended general dietary guidelines. But, requirement of healthy lifestyle is to design a framework which considers personal profile, medical history, level of disease, diet restrictions, food availability, and users' preferences in defining recommendations.

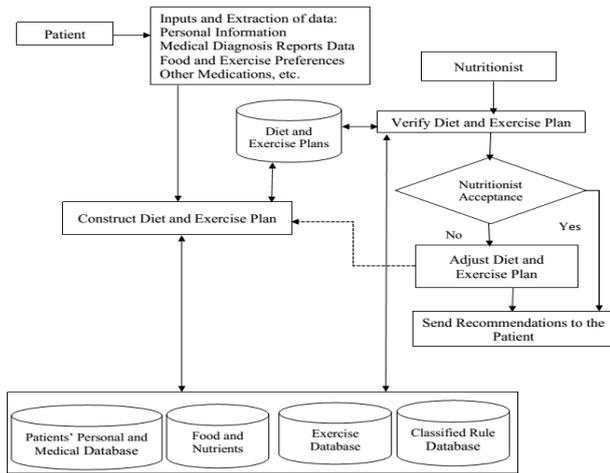


Fig. 1. Proposed recommendation framework

The proposed framework has following six phases as given in Fig.1

▪ *Collection of Patient's Information*

It provides patients' health profile. It evaluates other additional information, like, Body Mass Index (BMI), daily needed calories and Basal Metabolic Rate (BMR).

▪ *Food Items and its Nutrients Extraction Phase*

It extracts foods from different food groups. It also calculates calories, required portion size and nutritional values of each food item.

▪ *Exercise Information Extraction Phase*

It provides the list of exercises with intensities required to burn calories. By knowing how much calories should have been burned, it initiates the different activities with intensity and duration.

▪ *Diet Planning Phase*

The first step is to evaluate the amount of calories needed to suggest the diet plan. Next stage considers the required calories, food items, health issues restrictions, inclinations and current key side effects. Diet plans are generated by integrating all above factors.

▪ *Exercise Planning Phase*

It estimates the required calories to burn based on daily food intake. Next step suggests the list of exercises with intensity and duration that to burn the extra consumed calories. It also considers physical activities preferences given by patients.

▪ *Incorporating intelligence from nutrition experts*

The recommendations generated by the proposed systems are send to medical expert for validation of results. The lists of food items and physical exercises are revised based on medical expert's approval.

▪ *Recommendation Generation Phase*

The framework generates the suggestions for diet and physical activities based on individual's personal and medical data. The generated recommendations are validated by medical expert. These recommendations are provided to the patients once it gets validated by nutritionist.

IV. DISCUSSION

Inadequate and inappropriate intake of food is known to cause various health issues and diseases. The personalized concise information regarding healthy diet is difficult to

obtain from generalized recommender systems. So, people may rely more on medicines rather than ensuring preventive measures in food intake and fitness. Finding of appropriate diet and exercise plan is critical for individuals having non-communicable diseases like thyroid disorder, diabetes etc. Therefore, recommendation frameworks provide an effective solution to address above issues. This proposed work helps individuals to adopt healthier food choices and to follow healthy lifestyle.

We have interacted with dietitian frequently to understand the balanced food requirement for hypothyroid patients. Table I and Table III described the sample recommendations for hypothyroid patients suggested by dietitian. Different food groups are considered for meal planning.

Table: I Initial diet plan of 1200 cal for a hypothyroid patient suggested by dietitian

Meal	Food Items	Portion Size	Calories(gms)
Early Morning	Warm water with lemon + Medicine(mcg)	1 Glass	5
Breakfast	Dosa plain + Tea/Coffee with milk without sugar	2 pieces + 1 Cup	293
Mid Morning	Apple	1 small	132
Lunch	Vegetable salad + Vegetable curry +Roti +Curd	1 Bowl + 1 Bowl + 1 piece +1 Bowl	373
Snack	Tea/Coffee with milk without sugar	1 cup	120
Dinner	Lady finger subji +Roti + Red gram dal	1 bowl +1 piece+1 bowl	279

The nutritional information of food items is given in Table II. As per the design of proposed system, we are going to consider patient's food and activity preferences This initial diet and physical activities plans have been modified as per the hypothyroid patient's requirements. The proposed recommender system designs a well-balanced optimal diet plan with essential nutrient values as shown in Fig.2. At the same time, it considers an experienced nutritionist to validate the recommendations generated by the proposed system.

Table II : Nutritional insights Information:

Nutrients	Quantity	Daily Budget %
Proteins (gm)	37.3	61
Carbs (gm)	182.6	119
Fats (gm)	36.3	89
Fiber(gm)	25.4	85
Calcium (mg)	711.1	119
Iron(mg)	11.7	69
Zinc(mg)	0.4	4
Magnesium(mg)	216.5	70
Cholesterol(mg)	64.6	65

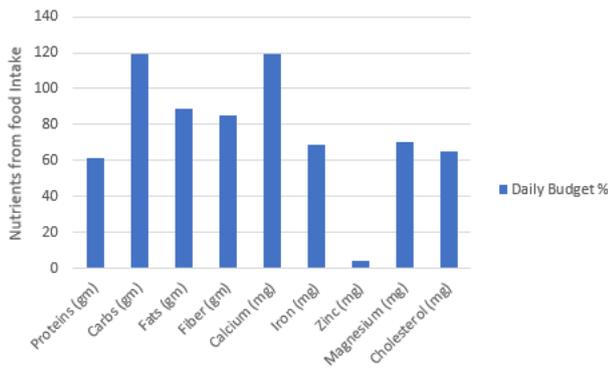


Fig. 2 Nutritional values from food intake

Table :III Initial Exercise plan

Exercise	Duration	Intensity	Calories Burned (Cal)
Walking	30 mins	Moderate	105
Plank	1 min	High	26
Burpees with Squats	10 mins	High	128
Jumping Jacks	60 reps	High	13

V. CONCLUSION

Hypothyroidism has profound impact on health and well-being. Hypothyroid patients have a risk of weight gain as well as other cardiovascular diseases. Imbalanced levels of thyroid hormones may lead to higher blood lipid profile. Hypothyroid patients experience abnormal gain in their body weight. They find difficulty to lose weight due to imbalanced hormone levels. Many nutritional factors have an importance to stabilize the thyroid hormones and increases the metabolic rate. The food and exercise recommender systems for specific diseases recommend different foods for patients without knowing their level of disease. The recommendations may vary in different cases. The goal of this study is to predict the level of hypothyroid disease and to recommend a personalize diet and exercise to hypothyroid patients with consideration of their level of disease and preferences. Future work is to develop proposed framework with effective methods of machine learning for expected results.

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