

EXPERT SYSTEM FOR NUTRITION EDUCATION COMBINING POINTS SYSTEM DIET AND FOOD GUIDE PYRAMID

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ABSTRACT

One of the health topics most discussed in the last years relates to obesity and overweight which are defined as abnormal or excessive fat accumulation that may impair health. Experts agree that all risk factors involved with obesity (heart disease, high blood pressure, high cholesterol, diabetes etc.) can be improved by a reduction in weight. Most of the diets work for a period of time but have no mechanisms for teaching the patients how to keep the new weight. This paper presents a Ruled-Based Expert System developed to help individuals that need to lose weight, which combines the Points System Diet and the USDA MyPyramid. A nutrition education approach is implemented aiming to reach a balance of food intake linked with healthy choices. An ongoing development of a prototype expert system used for nutrition education by combining the Points System Diet and the USDA MyPyramid is presented.

KEYWORDS

Health, nutrition education, points system diet, food guide pyramid, expert system.

1. INTRODUCTION

The World Health Organization (WHO), created in 1948, is the directing and coordinating authority for health within the United Nations system, responsible for providing leadership on global health matters, shaping the health research agenda, setting norms and standards, articulating evidence-based policy options, providing technical support to countries and monitoring and assessing health trends. One of the health topics most discussed in the past years relates to obesity and overweight which are defined as abnormal or excessive fat accumulation that may impair health. The numbers are astonishing: overweight and obesity are the fifth leading risk for global deaths and at least 2.8 million adults die each year as a result of being overweight or obese. In addition, 44% of the diabetes burden, 23% of the ischemic heart disease burden and between 7% and 41% of certain cancer burdens are attributable to overweight and obesity. (WHO, 2013).

On its annual meeting in June 2013, the American Medical Society (AMA) officially recognized obesity as a disease. This has broken the paradigm of obesity being a consequence of a chosen lifestyle exemplified by overeating and/or inactivity, and help changing the way the medical community tackles this complex issue that needs treatment.

The experts agree that all risk factors involved with obesity (heart disease, high blood pressure, high cholesterol, diabetes etc.) can be improved by a reduction in weight. Weight reduction has been shown to improve glycemic control and cardiovascular risk factors associated with insulin resistance in obese individuals with type 2 diabetes (Halpern and Mancini, 2005).

The weight loss market has been growing fast, and every day there is a new diet on the media, usually a miracle one. Most of them do not take into account a balanced and healthy diet. Furthermore, there is no use in losing weight without learning to keep the new weight. The Brazilian endocrinologist Alfredo Halpern has proposed a diet based on points (Points System Diet), instead of calories, whose premise is that the individual could eat everything but noting the need to control the number of points eaten in a day and not exceeding an amount previously calculated according to individual's weight, age, sex and physical activity. According to Halpern (2013), in a traditional diet, the individual that decides to eat a cheeseburger one day, breaking the

rules, thinks he had blown it and gives up the diet. In the Points System Diet (PSD), there are no forbidden dishes, since on the next day the person compensates the “extravagance” by ingesting fewer points.

The advantages of the PSD are the practicality and convenience, since the person can eat anything, provided he does not exceed the limit of points. In addition, the table of points is easier to use than memorizing the number of calories of each food. Another factor that can be positive is that as the individuals have the freedom to eat what they like provided they do not exceed the limit of points, they are more likely not to abandon their diet.

On the other hand, the food freedom of choice can make the PSD harmful to health, since it goes against what is meant by a balanced diet, in which foods should be distributed proportionally between carbohydrates, vegetables, fruits, protein and fats. On the medium and long terms, depriving the body of essential nutrients to its perfect functioning can cause a number of diseases, such as osteoporosis, diabetes, cardiovascular disease and hypertension, for example.

In 1992, trying to find links between diet and health, the United States Department of Agriculture (USDA) introduced the Food Guide Pyramid, recommending the intakes for each food group: grains, vegetables, fruits, milk, meat & beans and oil (USDA, 1992). In 2005 this pyramid was replaced by MyPyramid which takes into account nutrient-rich foods recommended for daily consumption, and offers a personalized approach to healthy eating and physical activity. A reminder of the importance of daily physical is represented by a person climbing steps and the colored bands identify the food groups. (USDA, 2005).

Therefore it is very important that the individual tries to vary the menu by not eating only thinking of scoring. It is essential to check and distribute the points between healthy foods so there is no lack of important nutrients in the future. A possible solution could be the combination of the principles: the Points System Diet and the USDA MyPyramid.

The use of digital technologies (mobile devices, photos, images, etc.) and Artificial Intelligence can substantially collaborate with stakeholders (patients and physicians) in this matter. In artificial intelligence, expert systems are designed to solve complex problems by reasoning about knowledge, like an expert, and not by following the procedure of a developer as is the case in conventional programming (Russell and Norvig, 2004). Expert systems are designed to solve a variety of complex problems by reasoning about knowledge by emulating the decision-making ability of a human expert. They can support many areas including medicine, engineering, and geology, among others. Albarrán (2005) describes how these kinds of systems can be used to support diabetes treatment, that can be used remotely (Internet) including a strong Educational component.

In this context, the objective of this paper is to present an Expert System developed to help individuals that need to lose weight, by combining the Points System Diet and the USDA MyPyramid. By controlling the consumption of points along the day, it would be possible to reach a balance of food intake combined with healthy choices. Therefore, the system proposed has also a nutrition education approach, allowing the individual flexibility of choices but, at the same time, leading to a better long time change in eating habits and behavior. Thereby, the methodology applied is presented and some considerations for further developments are discussed.

2. METHODOLOGY

2.1 Initial Considerations

Firstly, an heuristic was developed to map the sum of points that the individual could ingest during the day based on the eight different categories considered in the USDA MyPyramid: carbohydrates, meat, fruits, legumes, vegetables, milk, sweets and oils. This way, it was possible to reach a limit of points in each category, reaching the objective of following the PSD combined with the pyramid, allowing more flexibility.

For the purposes of the system, the calculation of total points per day was based on a healthy individual, nearly sedentary, and considered an average between 400 and 500 points per day. It is worth mentioning that this value can be greater or smaller, depending, for instance, on individual's height and weight.

Each category was considered individually and its respective items were mapped, taking into account an average of points in each of them. Since the items included in the vegetable category usually low in terms of points and for some items the consumption is free, they were not included in this mapping. Table 1 shows the

results of this calculation based on the heuristic. Notice that the sum of total points is 450, which is an average between 400-500 maximum per day:

Table 1. Maximum points allowed per day per category

| Food Category | Maximum of points allowed per day |
|---------------|-----------------------------------|
| Carbohydrates | 125 |
| Meats | 60 |
| Milk | 65 |
| Legumes | 50 |
| Fruits | 50 |
| Sweets | 70 |
| Oil | 30 |

2.1 System Development

A prototype system was developed after mapping the allowed points in each category aiming at helping the individual, based on the items consumed until that moment during the day, to choose the next items, giving hints and advices on the overall concept of a healthy paradigm. The Microsoft C# object-oriented (class-based) programming language was used to develop the application. The system can be used at any moment during the day, preferably after the main meals so the individual is able to control and decide what he is going to eat in the remaining of the day. The user interface provides boxes where the user can choose, in each category, what was consumed and then press “Add/Verify”. After the user chooses all items and presses the button, the system uses an inference engine, based on IF/THEN commands, to generate a report which provides the number of points that can be consumed on the rest of the day, as well as, advices on how to “spend” this in a healthy way. There are eight classes defined in the inference system, representing each food category. When the user runs the software, an object is created for each class, with a consumption limit associated with it, which decrements its value according to the users’ choices. Figure 2 shows the Carbohydrates class with the maximum value instantiated by the integer variable “*limite_carboidrato*”, which receives the value of 125 points.

```
public class Carboidratos
{
    BancoDados bd = new BancoDados();
    int limite_carboidrato;

    public Carboidratos(int id)
    {
        limite_carboidrato = bd.get("carboidrato",id);
    }

    public Carboidratos(){
        limite_carboidrato = 125;
    }
}
```

Figure 2. Example of carbohydrates class, with the maximum limit per day indicated in the red circle

In the system code, food items are distributed in classes that represent food categories. Each object of these classes has a decrementing function that is responsible for checking which items have been selected by the user and subtracting the available points in the category. The objects have a variable that represents the maximum limit of points to be consumed. Figure 3 shows the decrementing function for the Carbohydrates category, where it can be noticed the sentences “if, then” aiming at verifying which food categories were chosen by the user and decrementing the total points from the maximum consumption allowed daily.

```

public void decrementa(String alimento)
{
    if (alimento == "Arroz - 10 pts")
    {
        limite_carboidrato = limite_carboidrato - 10;
    }

    if (alimento == "Batata frita - 80 pontos")
    {
        limite_carboidrato = limite_carboidrato - 80;
    }

    if (alimento == "Biscoito recheado - 18 pontos")
    {
        limite_carboidrato = limite_carboidrato - 18;
    }

    if (alimento == "Esfiha - 60 pontos")
    {
        limite_carboidrato = limite_carboidrato - 60;
    }
}

```

Figure 3. System inference showing how to decrement the maximum limit value allowed to carbohydrates category

Each class has its own inference system, i.e., each object is responsible for decrementing the maximum allowed value per day according to its category, using the function “*public void decrementa(String alimento)*”, where “*alimento*” is the string which contains the item consumed and selected by the user in the system. Finally, the system verifies the maximum value left in each object and generates a didactical report.

3. CONCLUSION AND FUTURE WORK

The objective of this paper was to present an ongoing development of a prototype expert system used for nutrition education by combining the Points System Diet and the USDA MyPyramid. However the system was not tested yet with the real potential users. Furthermore, the system can be improved by feeding the database with more food items and inserting new inference mechanisms that make available more choices for the individuals. Other adaptations of the system might include individuals with food restrictions or diseases, for instance, diabetes.

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