NutriScale

Key Figures for Food Selection

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Background

People appreciate guidance in their food choices, especially if they have diet-related diseases. Providers of nutrition mobile phone apps are trying to enhance users' food orientation. Currently, those apps are adequate for acquiring food-related information, but algorithms that evaluate a user's food intake are lacking. The NutriScale algorithm is closing this gap. The scientific foundation of NutriScale is based on the three-dimensional food pyramid[1] and the Nutrition Circle[2]. The pyramid and the circle were created and are distributed by the German Nutrition Society (DGE).

Methods

Various apps for food-related data acquisition were analysed, and the common functions that were used for user-friendly input were identified. The available functionality of those apps was compared to professional software tools used by nutrition therapists. Furthermore, existing models for applying food and health-related information to daily routines were evaluated. Considering all these factors, a web application was developed. The application offers users easy food data input and delivers helpful scores for making food-related decisions.

Food pyramid of German Nutrition Society (DGE)

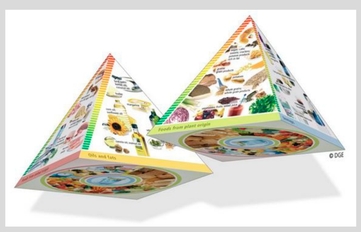

Figure1: Three-dimensional Food Pyramid

Figure 2: Nutrition Circle on the Base of the DGE Pyramid

The most important feature of the three-dimensional food pyramid (Figure 1), developed by the DGE, is the combination of quantitative recommendations (Nutrition Circle on the base) and information about food quality (represented by the four pyramid sides) in a single model. Food items are classified into the four major groups represented by each side of the pyramid: (1) Foods from Plant Origin (Figure 3), (2) Foods from Animal Origin (Figure 4), (3) Oils and Fats (Figure 5) and (4) Beverages (Figure 6). On each pyramid side, the foods are ranked according to their nutritional value. Foods with high nutritional value are at the bottom of the pyramid side (marked in green to show they can be consumed generously), foods with medium nutritional value are placed in the middle (marked in yellow). Those with low nutritional value are at the top (marked in red to show they should be consumed sparingly).

Information regarding the quantity of food intake can be inferred from the Nutrition Circle (Figure 2) on the bottom area of the pyramid. It is segmented based on the calculated quantities of the different food items. The segments represent the relative quantities of the different food groups which are required for an adequate and well-balanced diet. The Nutrition Circle recommends high consumption of vegetables, fruits and cereals, adequate fish consumption and a reduction in the consumption of meat (particularly red meat), fats and sausages.

Figure 3: Foods from Plant Origin Pyramid Side

Figure 4: Foods from Animal Origin Pyramid Side

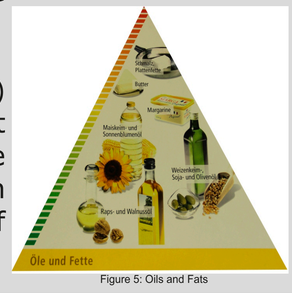

Figure 5: Oils and Fats

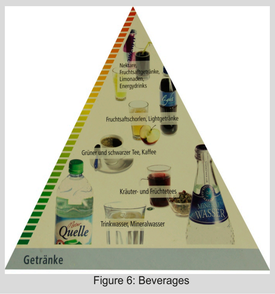

Figure 6: Beverages

NutriSale

NutriScale consists of two figures: Nutri-Scale ratio (NSR, see Formula 1) and NutriScale score (NSS, see Formula 2).

NutriScale-Ratio (NSR)

NSR relies on the Nutrition Circle with its proposed ratio of vegetable to animal food as 3:1.

$$\alpha = \frac{\frac{\text{(Real Intake Plant Food in Grams)}}{\text{(Real Intake Animal Food in Grams)}}}{\frac{\text{(Intended Intake Plant Food in Grams)}}{\text{(Intended Intake Animal Food in Grams)}}} * 100\%$$

Formula 1

Converting α to NSR:

α (%)	>=0	>=10	>=20	>=30	>=40	>=50	>=60	>=70	>=80	>=90
NSR	1	2	3	4	5	6	7	8	9	10

NutriScale-Score (NSS)

NSS takes into account the food groups mapped to the four sides of the pyramid. Each group is assigned a points value between 1 (top group) and 10 (bottom group).

$$NSS = \frac{\sum_{(i=1)}^{n} Weight_i * Score_i}{\sum_{(i=1)}^{n} Weight_i}$$

Formula 2

Here, weight is in grams and i represents the food item.

Example: Calculating NSR and NSS for a meal

Meal: Pollack with Potatoes
Pollack: 250 g, 100 % animal origin, fish group (10)
Potatoes: 300 g, 100 % plant origin, potato group (5)

$$\alpha = \frac{\frac{300}{250}}{\frac{75}{25}} * 100\% = 40\,\%, \quad NSR = 5$$

$$NSS = \frac{(250*10+300*5)}{(250+300)} = 7.27$$

The NSS and NSR values give an idea about how healthy one's food intake is.The users should always strive for higher values of NSS and NSR than what they are getting for their current food intake. This could result in healthier eating habits.

Four Food Groups

Pyramid Side	Evaluation Criteria
Foods from Plant Origin	Energy density, nutrient density, micronutrients (vitamins and minerals), fibre, phytochemicals and dietary fibre, preventive effects on the prevalence of chronic diseases (eg. cancer, cardiovascular diseases)
Foods from Animal Origin	Energy density, nutrient density (eg. calcium, iron, zinc, selenium and B vitamins), fatty acid composition (saturated fatty acids, n-3 fatty acids), undesirable by-products, preventive aspects from epidemiological studies with respect to chronic degenerative diseases (eg. cancer, cardiovascular diseases)
Oils and Fats	Fatty acid composition (saturated, monounsaturated and polyunsaturated fatty acids; trans-fatty acids), ratio of n-6:n-3 fatty acids, vitamin E, cholesterol, practical aspects (use of oils/fats in cooking), preventive aspects
Beverages	Energy density (% carbohydrates: medium: <7% carbohydrates: high: >7% carbohydrates), vitamins, contents of secondary plant metabolites, content of stimulating substances like caffeine, sweeteners

Table 1. Criteria for ranking of food on each side of the DGE 3D Food Pyramid

Values of Different Food Items in the Four Food Groups

Foods from Plant Orgin

Food Item (English)	Food Item(German)	Value
Sugar , Cake, Candy , Snacks , High-fat Potato Products	Zucker, Kuchen, Süßigkeiten, Knabbereien, Fettreiche Kartoffelprodukte	1
Cereal Products, Husked Rice	Getreideprodukte, Geschälter Reis	4
Potatoes	Kartoffeln	5
Whole Grain Products, Paddy	Vollkornprodukte, Ungeschälter Reis	7
Vegetables, Fruits, Green Salads, Juices	Gemüse, Obst, Blattsalate, Säfte	8

Table 2: Values assigned to Food items in Food Group 1

Foods from Animal Origin

Food Item (English)	Food Item(German)	Value
Bacon	Speck	1
High-fat Meat Products, Eggs and Cream	Fettreiche Fleischwaren, Eier, und Sahne	3
High-fat Milk and Milk Products, High Fat Meats	Fettreichere Milch und Milchprodukte, Fettreicheres Fleisch	5
Low-fat Milk and Milk Products	Fettarme Milch und Milchprodukte	6
Low-fat Meat and Meat Products	Fettarmes Fleisch und Fettarme Fleischwaren	9
Fish	Fisch	10

Table 3: Values assigned to Food items in Food Group 2

Oils and Fats

Food Item (English)	Food Item(German)	Value
Shortening	Schmalz, Plattenfette	1
Butter	Butter	2
Margarine	Margarine	3
Corn and Sunflower Oil	Maiskeim- und Sonnenblumenöl	5
Wheat, Soya and Olive Oil	Weizenkeim-, Soja- und Olivenöl	6
Canola and Walnut Oil	Raps- und Walnussöl	9

Table 4: Values assigned to Food items in Food Group 3

Beverages

Food Item (English)	Food Item(German)	Value
Nectars, Fruit Juices, Sodas, Energy Drinks	Nektare, Fruchtsaftgetränke, Limonaden , Energy Drinks	1
Fruit Juice Spritzers and Light Beverages	Fruchtsaftschorlen und Lightgetränke	4
Green and Black Tea, Coffee	Grüner und Schwarzer Tee , Kaffee	7
Herbs and Fruit Tea	Kräuter und Früchtetee	9
Drinking Water and Mineral Water	Trinkwasser und Mineralwasser	10

Table 5: Values assigned to Food items in Food Group 4

Results

Among the various mobile apps that were analysed, the "Jawbone Up" app was found to provide a user-friendly data acquisition of eating habits[3]. The DGE food pyramid model is a suitable foundation for automated evaluation of food consumption and thus an appropriate basis for NutriScale. NutriScale outperforms currently available nutritional rating systems due to its simplicity. In future projects, NutriScale should be included in existing software solutions, for example, "Jawbone Up". Through such an integration, it is possible to also examine a user's physical activity and develop a more holistic health picture. Afterwards, there should be an evaluation of how helpful the algorithm is for supporting health-related decision-making processes.

Discussion

It is helpful to use a model instead of trying to collect all the relevant information, ie. micronutrients etc., because of following factors:

- It is hard to access, find and interpret micronutrient data for food items from databases like Bundeslebensmittelschlüssel or the USDA National Nutrient Database.
- Moreover, accessing Bundeslebensmittelschlüssel is time-consuming and expensive due to licensing issues. Although the USDA National Nutrient Database is an open source database, it is harder to integrate.
- Pre-processed food items are not part of these databases; hence, there is no way to get information about such items.
- Only professional software tools like DGExpert or NutriGuide are able to integrate those databases as their sources to support therapy processes.

It seems helpful to use an accepted model representing a healthy diet, in this case, the three-dimensional DGE pyramid. Using such a model provides the following advantages:

- It is possible to rate all food items and meals, including processed meals.
- The models consider the quantity and quality of food consumption.
- Users are able to understand the logic behind the calculation of the scores.
- Users are able to gain knowledge about different food ingredients.
- The recommendations are based on scientific evidence.
- The model is continuously improved and adapted.

The implementation of NSS as a publicly-available web service provides the following benefits:

- Users are able to add their own meals.
- Users are able to consider only meals with verified ratings.
- The service will be available to enrich other apps, i.e. Jawbone Up and smart home devices[4].

The user experience needs to be evaluated for potential improvements. Moreover, we need to determine if NSS helps to change existing health-related habits. The DGE pyramid model used here does not consider the cooking procedure followed. NutriScale could be made more accurate if cooking procedures are also considered.

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