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SOFTWARE FOR NUTRITIONAL ASSESSMENT OF PEOPLE WITH GLUTEN-RELATED DISORDERS

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Abstract. In the context of complex nutrition issues, nutritional assessment software for people with gluten-related disorders can be a precious tool for professionals in the field. It could serve as a support for novice nutritionists. The purpose of this research is to develop software for the nutritional assessment of people with Gluten-related disorders (GRDs) in the Republic of Moldova, intended for nutrition students. The development of the Software followed the systemic approach of the Nutrition Care Process, which is a graphical visualization illustrating the internal and external steps and factors that influence the use of the process. The nutritional Software was developed based on the information system *Embarcadero RAD Studio Alexandria Edition, having Microsoft SQL Server as a database*. The developed Software offers a personalized and precise approach, taking into account the consumer's anamnesis, the results of clinical evaluations, and anthropometric parameters, but also specific biomarkers for GRDs and offering the possibility of data recording, scanning and archiving of the results obtained from the laboratories analysis sampling. The system includes functionality to monitor and evaluate client progress toward health goals, and nutrition users can effectively track progress and make appropriate adjustments.

Keywords: *biomarkers, body composition, celiac disease, Nutrition Care Process, nutritional security, Republic of Moldova, Technical University of Moldova.*

Abstract. În contextul problemelor complexe de nutriție, software-ul de evaluare nutrițională pentru persoanele cu tulburări asociate consumului de gluten poate fi un instrument prețios pentru profesioniștii din domeniu și un suport pentru nutriționiștii începători. Scopul acestei cercetări constă în dezvoltarea unui software pentru evaluarea nutrițională a persoanelor cu tulburări asociate consumului de gluten (TACG) din Republica Moldova, destinat studenților la nutriție. Dezvoltarea Software-ului a urmat abordarea sistemică a Procesului de Asistență a Nutriției, care este o vizualizare grafică și care ilustrează pașii și factorii interni și externi care influențează utilizarea procesului. Software-ul nutrițional a fost dezvoltat pe baza sistemului informațional *Embarcadero RAD Studio Alexandria Edition,* având ca bază de date *Microsoft SQL Server*. Software-ul dezvoltat oferă o abordare personalizată și precisă, ținând cont de anamneza consumatorului, de rezultatele evaluărilor clinice și de parametri antropometrici, dar și de biomarkeri specifici pentru TACG și oferind posibilitatea înregistrării

datelor, scanării și arhivării rezultatelor obținute din laboratoare analize prelevare de probe. Sistemul include funcționalități de monitorizare și evaluare a progresului clientului către obiectivele de sănătate, iar utilizatorii de nutriție pot urmări eficient progresul și pot face ajustările corespunzătoare.

***Cuvinte cheie**: biomarkeri, boala celiacă, compoziția corporală, Procesul de Asistență a Nutriției, securitatea nutrițională, Republica Moldova, Universitatea Tehnică a Moldovei.*

1. Introduction

The global food and nutrition crisis is considered the leading cause of poor health [1] and continues to worsen, exacerbated by the pandemic. Almost a third (2.3 billion, or 29.3%) of the world's population was moderately or severely food insecure in 2021, up from 25.4% before the pandemic [2]. Experiencing food insecurity is increasingly associated with adverse health effects and a greater likelihood of developing chronic diseases [3].

In the context of complex nutrition issues, nutrition software can be a precious tool for professionals in the field. It could serve as a support for nutrition students as well as practitioners. Internationally, multiple Software are being developed, either customer-focused or aimed at nutrition specialists, characterized by a different degree of complexity and coverage of needs. At the same time, there are few scientific works concerning the development of these tools [4,5].

The issues of ensuring nutritional security and the human right to adequate food for people with disorders associated with gluten consumption in the Republic of Moldova are susceptible, becoming even more prominent under the pressure of crises (Covid-19 pandemic and the war in Ukraine) [6].

Being among the most common chronic digestive conditions, Gluten-related disorders (GRDs) is often underdiagnosed and neglected by patients and doctors, and the number of people affected, in reality, is much higher than it is believed. The process of adopting and adhering to a gluten-free regime is a rather difficult one, vulnerable on all dimensions of food security because gluten-free products are not produced or certified in the Republic of Moldova [7].

The limited participation of nutritionists in the development of balanced menus or their total lack in public catering units, the low diversity of gluten-free products and the high cost, compared to their gluten counterparts, the risk of cross-contamination of food, the developing offer of social assistance services and nutritional care etc. - all this reflects only part of the challenges faced by people with GRDs in the Republic of Moldova [8–10].

The purpose of this research is to develop a software for nutritional assessment of people with GRDs in the Republic of Moldova, intended for nutrition students.

The development of nutritional software is justified by the imperative of nutritional information and education as one of the causes of nutritional insecurity of people with GRDs [11]. The Software will enhance the learning ability of students as future nutrition practitioners, which will help eradicate nutritional illiteracy.

It will help streamline the management of data related to studies and their clients by recording detailed information about tested diets, results obtained, and other data relevant to research and analysis.

The nutritional Software can be accessed remotely, which allows the user (student) to work with his data from anywhere. This can be especially useful when doing research and studies in collaboration with other students or professors or when working with clients who live in remote areas. It can be programmed to provide detailed analysis and reports to help

better understand eating habits and identify changes that could be made to improve the tested diets.

2. Materials and Methods

The development of the Software followed the systemic approach of the Nutrition Care Process, which is a graphical visualization illustrating the internal and external steps and factors that influence the use of the process [12] (Figure 1).

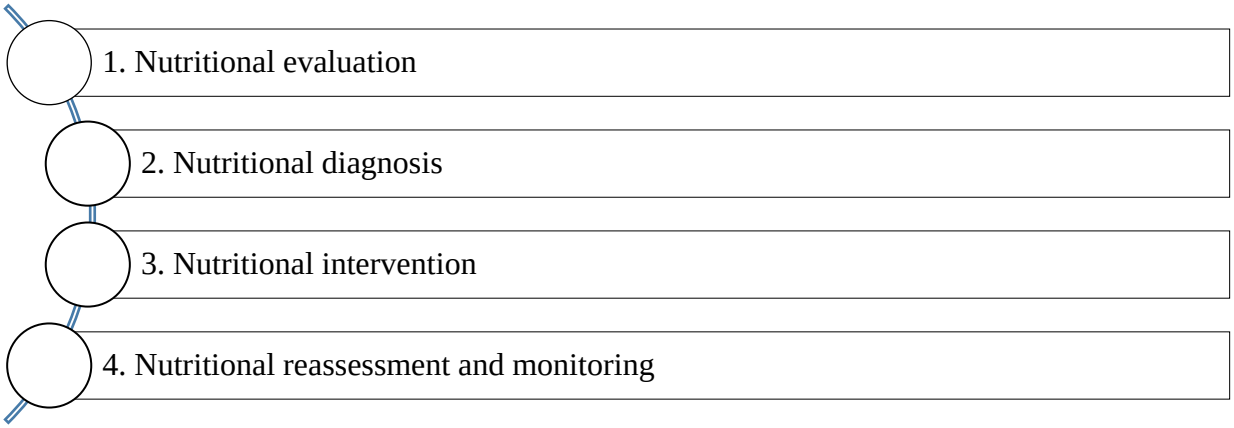

Figure 1. Stages of the Nutrition Assistance Framework model.

Software programming. The nutritional Software - SNUTM (SNUTM – Soft Nutrițional Universitatea Tehnică a Moldovei / Nutritional Software, Technical University of Moldova) was developed based on the information system Embarcadero Rapid Application Development (RAD) Studio Alexandria Edition (Figure 2) - is an object-oriented, visual programming environment, having Microsoft Structured Query Language (SQL) Server – is a programming language for storing and processing information in a relational database (Figure 3).

Figure 2. Embarcadero Information System RAD Studio Alexandria Edition.

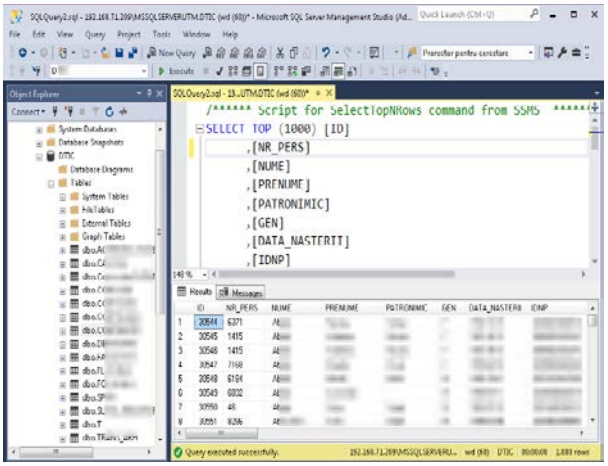

Figure 3. The (SNUTM) software product, developed based on Microsoft SQL Server.

The system has several advantages: performance, with the fastest compiler; the possibility of reusing the components; containing specialized details in database programming; the chance of developing mobile applications; development of web applications; cross-platform use; simplicity and speed of service, etc.

The parameters included in the SNUTM system are general and specific [13], taken from the scientific literature (Tables 1, 2).

Table 1

Parameters used in software development

Software Components	Source
Anthropometric measurements	[14–19]
Body composition parameters and equations: Body Mass Index, Lean Metabolic Rate, energy requirement, ideal mass.	[20]
Biomarkers, medical tests, etc. to identify nutrient deficiencies	[13]
* Biomarkers for the diagnosis of celiac disease (CD)	[13]
Calculation equations of energy value and nutrients	[21]
* Guidelines for the diagnosis of MC, developed by the Society of Pediatrics and Gastroenterology, Hepatology and Nutrition (ESPGHAN)	[13,22,23]
Menu analysis questionnaire	[22,24,25]
*Gastrointestinal Symptom Rating Scale (GSRS) questionnaire	[26–28]
* Gluten-free diet adherence questionnaire	[29,30]
* Questionnaire for the evaluation of the quality of life of people with GRDs	[22,31]
Dietary Reference Values	[32,33]
* Links to useful guides on Celiac Disease	[34]

Legend: * GRDs specific parameters.

Table 2

Biomarkers for the diagnosis of celiac disease

Symptoms
Malabsorption syndrome
Other CD-relevant symptom or having T1DM or being a 1 st-degree family member
Asymptomatic
Serum antibodies*
EMA (**Anti-endomysial antibodies** positi**vity and /or** high positivity **(>10 ULN (U**pper Limit of Normal**))** for anti - **TG2**
Low positivity for anti-TG2 antibodies or isolated anti-DGP positivity (DGP - *Deamidated gliadin peptide*)
Serology was not performed
Serology performed but all* coeliac-specific antibodies negative
HLA
Full **HLA** – DQ2 **(în *cis*** or ***trans*)** or **HLA-DQ8** heterodimers present
No **HLA** performed or half **DQ2 (**only **HLA-DQB1* 0202)** present
HLA neither **DQ2, n**or **DQ8**
Histology
Marsh 3a (mild villous atrophy**)**, **3b (**marked atrophy**)** or **3c (**complete atrophy**)**
Marsh 2 or **3a (**moderately decreased villus height/crypt depth ratio**)**
Marsh 0-1 (it is not conclusive for CD**)**

Note: **Refers in IgA (Ig* – Immunoglobulin) deficiency *to IgG clas EMA, TG2 and DGP antibodies***. *Source: [13]***

3. Results and Discussion

The block diagram of the SNUTM software is represented in Figure 4.

Registration data includes identification and contact information, age, locality, nationality, living environment, education level, profession, etc. The Software allows user registration, with the subsequent possibility of him registering consumer-customers [4]. Contact details of the consumer's supervising physician may also be collected, alerting the student-user to the importance of active collaboration between the nutritionist and doctor [4]. The assessment begins with anthropometric measurements. The essential elements of anthropometry included in the system are: height, weight, body circumferences for adiposity assessment (waist, hip and limbs) and skinfold thickness [14]. These measurements are also used to calculate Body Mass Index, Basal Metabolic Rate, energy requirement, ideal mass, the ratio of muscle mass to adipose tissue, etc.

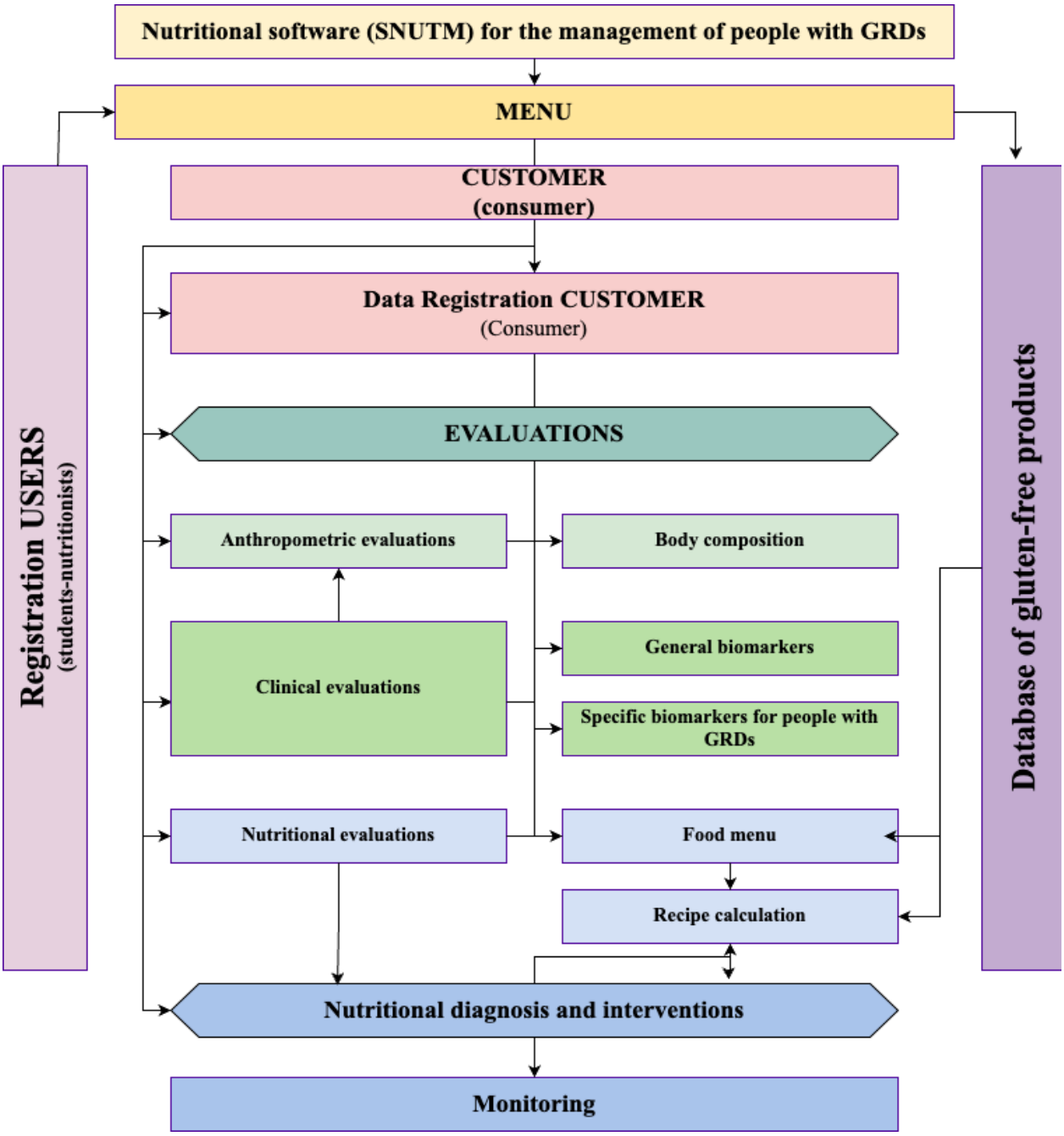

Figure 4. SNUTM nutritional software map.

The results could provide information regarding the patient's nutritional status, including a potential risk of undernutrition or obesity and possible consequences. Anthropometric data are frequently used to monitor the implementation and measure the effectiveness of food security and nutrition interventions and programs.

The Software offers data archiving, and time monitoring and even generates graphs concerning BMI, Basal Metabolic Rate, etc. (Figures 5-7).

Figure 5. Anthropometric data.

Source: Screenshot from the SNUTM nutritional software, developed by the authors.

Figure 6. Dynamics of anthropometric indicators

Source: Screenshot from the SNUTM nutritional software, developed by the authors.

The clinical evaluation will collect the patient's medical history: general physiological condition, symptoms, allergies, blood pressure, medical diagnosis, personal and hereditary collateral history, and medications. At the same time, the user can record in the program such biomarkers as values for blood count, insulin resistance and secretion, lipid metabolism and insulin stress, etc. Specific markers for the diagnosis of celiac disease included tissue anti-transglutaminase antibodies: Immunoglobulin A (IgA) and Immunoglobulin G (IgG) and anti-gliadin deamidated Immunoglobulin G (IgG) antibodies. Titles can be registered manually or by scanning analysis reports (from accredited laboratories), with the possibility of archiving (for monitoring).

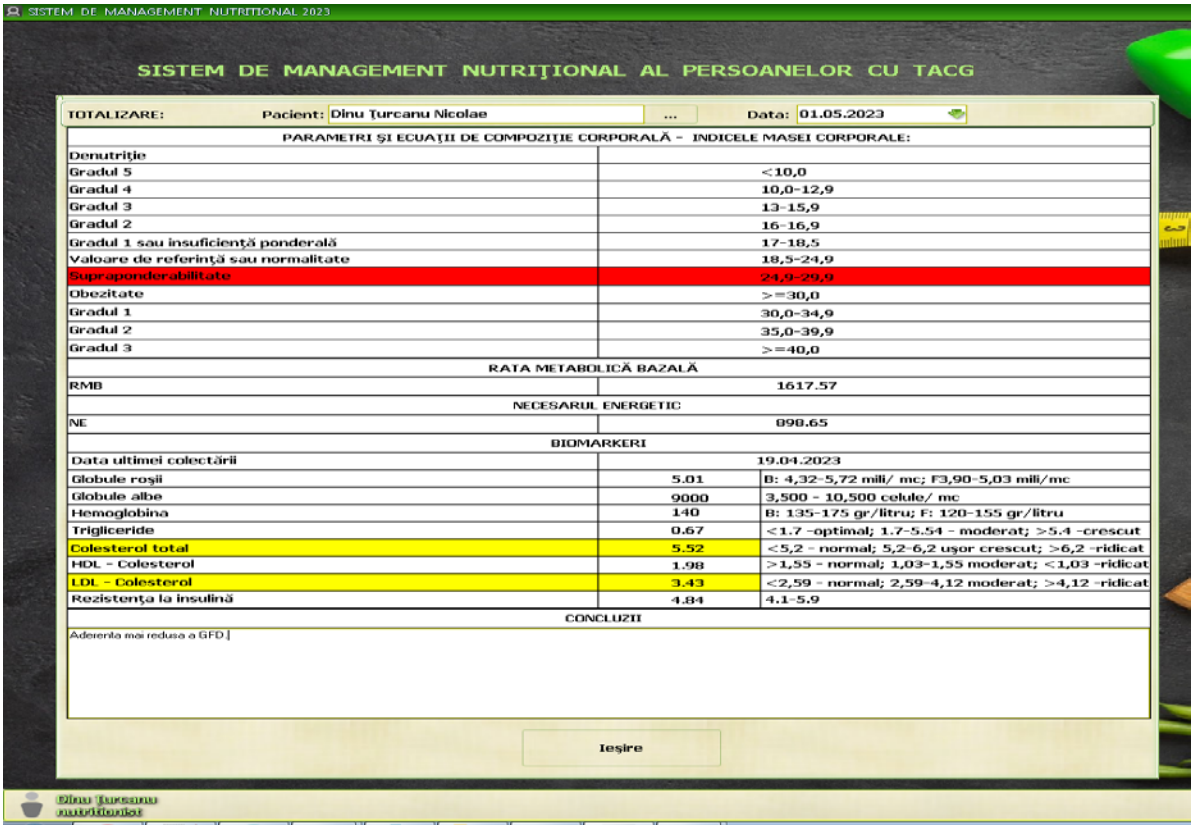

Figure 7. The response generated by the software as a result of data recording.
Source: Screenshot from the SNUTM nutritional software developed by the authors.

The nutritional assessment includes a questionnaire developed and validated by the European Society for Pediatric Gastroenterology, Hepatology and Nutrition (ESPGHAN) to measure gastrointestinal symptoms [13–15].

In addition to this questionnaire, the Software also includes two standardized questionnaires: a quality of life assessment questionnaire [22,31] and a gluten-free diet adherence questionnaire [29,30] .

At the current stage, the Software comes with feedback to the user so that, subsequently, it generates a nutritional solution vis-à-vis the consumer's diet. For the healthy solution, databases (DB) are required concerning the chemical and nutritional composition of food products. Due to the lack of a database in the Republic of Moldova, at the moment, this niche has only been completed with the group of products "bread and bakery products" GF.

The correctness of the results generated by the Software was verified by comparing the results of some equations about the nutritional status: Body Mass Index (BMI), Basal Metabolic Rate (BMR), energy requirement, etc., through the Software, but also manually.

5. Conclusions

Nutrition software SNUTM can be a valuable tool for a nutritionist student, allowing him to better learn the concepts and principles of nutrition, more effectively manage the data related to his studies, and test different scenarios and solutions regarding nutrition plans. It can also be a handy tool for monitoring your diet and lifestyle. With proper development, it can be customized to meet individual user needs and can be a valuable resource for education and training. It can contribute to creating recipes or food menus and their multidimensional analysis from various perspectives. And above all, it can improve the teaching/learning process compared to the traditional teaching format. Overall, nutritional management software for people with GRDs can be an invaluable tool in helping them maintain a balanced and varied gluten-free diet.

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Conflicts of Interest: The authors declare no conflict of interest.

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