R24móvel – 24 Hour Dietary Recall Mobile Application

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Abstract — **This article aims to present the application R24Móvel, for nutritionists, which was developed for tablets with Android operating systems, and to discuss issues related to the development of this application. The article will show the application structure, functionality and actuation area, as well as the relevance of the application within the field of nutrition, automating one of the most important dietary food intake assessments, the 24h recall.**

Keywords-nutrition; Android; Mobile application; 24h recall; dietary recall;

I. INTRODUCTION

Nutritionists use food intake queries as a tool to evaluate and estimate the food intake of a person or a population, which provides information that assists in determining nutritional behaviors, i.e. eating habits, dietary patterns. Normally, information about a client's food intake is determined by an interviewer, who reads from a form, and records the data on paper. Subsequently, the nutritional intake is estimated using a manual calculation, food composition tables, or software. This process involves repetitive procedures that require a lot of a manual work.

Dietary assessment methods that use some kind of software, have the potential to improve the evaluation process and allow the nutritionist to spend less time on the calculation process and more time interpreting the results and giving feedback to the patient. Dietary assessment applications provide better data entry, reduce the redundancy of food names, and can save time with data coding processing.

This work aims to present a solution for mobile devices with Android operating systems for 24-hour dietary recall [7], and the application store of the collected data using a relational database on the mobile device itself. The solution was developed following the specification of a nutritionist and compared to the paper method.

This article is organized as follows: Section II - a summary of the 24-hour recall dietary assessment method; Section III -- an overview of other proposals available for 24-hour recall food assessments; Section IV – shows the solution R24móvel that automates the method of 24-hour recall dietary assessment; Section V – the conclusions.

II. THE 24 HOUR RECALL

Dietary assessment methods aim to estimate the food consumed by a group or person within a certain time period, thereby identifying consumption patterns, which allows them to assess the client's nutritional status and get information from the collected data. The direct process of food intake analysis from dietary assessment is a good way to characterize the dietary patterns in a population and trace its evolution over time.

A 24-hour food recall (R24) is a method of dietary assessment that quantifies all food and drinks consumed by a person, within a 24-hour period prior to the interview. The interview is usually performed in a face-to-face encounter, but can be done remotely, by telephone, for example. Normally a nutritionist will interview the client, but interviews may also be done by anyone trained to carry them out. The interviewer should be informed about the eating habits of the region, about food preparation, regional cuisine and should perform the interview without influencing the interviewee's responses, to avoid the interviewee from providing biased answers, especially when the client is in doubt about his or her response.

The R24, being a non-structured method, allows access to details about the consumed preparations. It's also useful to estimate the consumption of a diverse cultural population who shows a large variation of food and habits, and this method don't chance the eating pattern, because the information is obtained after the consumption. Other advantages are, the time to apply the method (15-20 minutes) and the low cost of application.

III. RELATED WORKS

There are some applications available that can be used for 24 hour recall dietary assessments. Among those analyzed, some that merit recognition are: Nutwin [1], Nutrisurvey [2], ASA24 [3], NutriMobile [4] and the Doce Desafio [5].

Nutwin [1] is a program designed to support nutrition with calculations for nutritional assessments and the organization of the stored information, as well as helping to quantify nutrient intake information, and in the decision-making process during

the preparation of Food Plans. The application was developed to work with: concepts of form files, individual data, food and measurements. Nutwin has low portability because it works only on desktops, which eliminates its use in field research.

Nutrisurvey [2], is the English translation of software EBISPro, a German software for nutrition professionals. The program has an application in food analysis for creating diet plans (manual or automatic). It also provides diet history (diet protocol, diet history, food frequency), calculates individual demands, and is supported for work in network. Despite Nutrisurvey having a robust interface, it only works on desktop and it is not user friendly.

The ASA24 [3] platform is composed of two web-based applications, which present a set of features, for the respondent and for the interviewer. The ASA24 is employed by the users to perform food recalls that can be used by researchers, doctors and educators, to monitor and study. This web application provides access to nutrients and analyzes food groups. ASA24 works only on the web, and is a highly bureaucratic system to use.

NutriMobile [4] is a software to record the food intake of the user. The application assists in the perception of the amount of calories or points ingested. For a more detailed analysis, these results can be evaluated by a doctor or nutritionist, who can then assess the patient's diet. The application was developed for mobiles phones with Windows Mobile operational system. The solution only calculates calories, and was developed for a deprecated operational system, and is used exclusively for diet control.

Doce Desafio [5] is a software application for Android operating systems that has worked on all monitoring fronts of a program treatment for diabetes type 1. It can cover the four main variables relevant in the treatment: the measurement of blood glucose, the amount and types of insulin, food consumption, and physical activities.

Given this scenario, it is clear that there is a need for an application for mobile devices, with free open source software, which aims to unify the application and calculation of the 24h recall (R24) while assisting the data analysis of the answers to the interview questions. The R24móvel was developed with all of this in mind, and is described in the next section.

IV. R24MÓVEL NUTRITIONAL SOFTWARE

The nutritional application R24móvel is a solution for mobile devices with an Android operating system with the 24 hours recall method, to assist the recording and analysis of patient information.

A. R24móvel Characteristics

R24móvel has been developed, as already discussed, with the aim of creating an application in a mobile platform that is commonly used on desktop platforms. Some features of R24móvel are presented below:

- Since tablets with Android operating systems are cheaper than most desktop computers, the R24móvel should be more accessible for nutritional analysis.

- The R24móvel has a clean, user friendly interface, because of its features condensed features that follow the requirements of a nutritionist.

- The R24móvel was developed in a model where the interviewed person and the user should spend less time together, because of the nature of the work. Frequently, nutritionists report thinking that the respondent/client may tire because of the lengthy process required to complete the work, so it aims to do the work faster, and less bureaucratic in activity between the patient and the professional.

- The R24móvel features communication with other desktop applications already used by nutritionists. It was necessary to implement the feature of importing data from a .CSV file format obtained from .XLS file provide by IBGE (Instituto Brasileiro de Geografia e Estatística. Also, was developed a feature to export the data for .PDF format, and to .XLS format. With these, all the data of the database and results of the calculations can be exported. This way the interviewer can do calculations and analysis with these data in other platforms.

B. R24móvel Architecture

The proposed architecture for R24móvel is illustrated in Fig. 1 and consists of four modules, the module interface with the user, where are all the views and layouts with forms of input and output data to a person; food, measures, food recalls and import and export data.
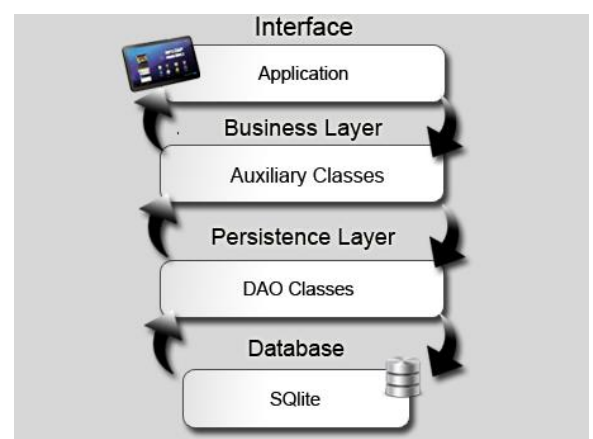

Figure 1 – Class Architecture Model.

The business layer consists of classes that prepare a data set, provided from the database, for a specific class in the Interface layer and other classes like controllers and class to perform calculations.

The Persistence layer, contains the DAO classes that have functions to persist with the database in SQlite, to provide data for the other classes, with the SELECT, INSERT, DELETE and UPDATE functions.

The Database is where all the database tables contract, relate and configuration are implemented.

C. R24móvel Conceptual Model

The R24móvel has implemented a database with the SQlite database manager [9]. The SQLite is an Android native platform. It is a relational database system – the data is stored in tables that could have relationships among themselves. The R24móvel database is embedded in the application, and is created in runtime when it is installed in the mobile device.

The R24Movel conceptual model consists in five entities and the relationships between these entities. The entities are:

- Patient: composed of the attributes id (primary key), name, last name, birth date, image, gender, height and weight;
- Recall: composed of id (primary key), time, local, meal and quantity;
- Nutrients: composed of the 54 nutrients from TACO;
- Food: with id (primary key), name, cooking method, origin and group; and
- Measurement: with id (primary key), name and quantity.

D. Workflow

The R24móvel application workflow can be summarized in the stages illustrated in the Fig. 2. As can be observed, the workflow is divided into three steps, which are: Data Collection, Analysis and Results. Each one of these steps is described below.
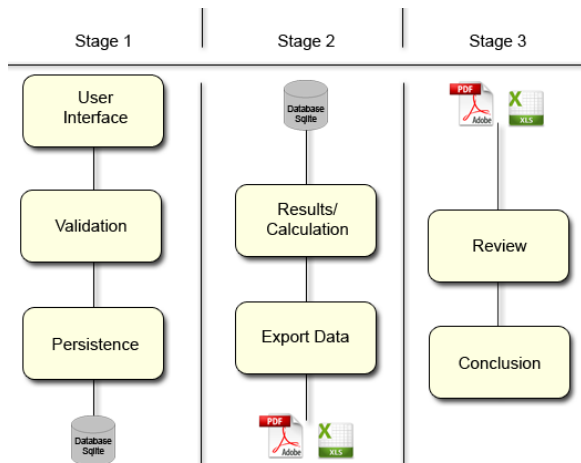
Figure 2. Application Workflow.

Stage 1: Data Collection

Stage 1 consists of collecting data in the field by the interviewer through their mobile devices. The modules that make up this step are: (i) User Interface, which is the data entering in the system through a set of electronic forms; (ii) Validation, where each form has a validation so that it is not missed or recorded incorrectly, and (iii) Persistence, which is responsible for storing the information in the mobile device database.

Fig. 3 shows the data R24móvel entry screen. Start, has all of the individual data, and is stored in the Patient table from the database. Fig. 4 shows the 24-hour recall data entry. It is available to the user, a set of form for the data collection stage. Also important are the Measurements shown in Fig. 5.

Figure 3. Individual Data Entry.
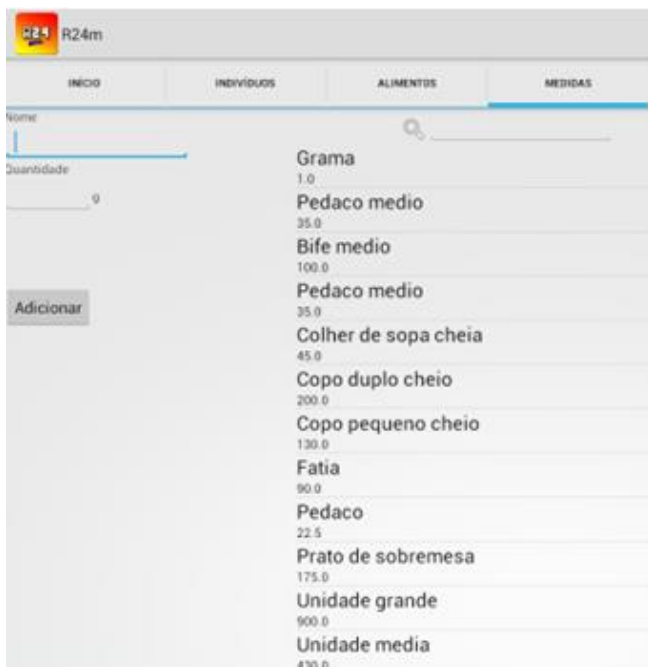
Figure4. 24h Recall Data Entry.

Figure 5. Measure Data Entry.

Stage 2: Data Collection

At this stage (Fig. 6) the interviewer will use the data collected in the field and stored in the database. The modules that comprise this step are:

- Results/Calculations: where the application will return the individual recall results;
- Export: where the interview will export to a .PDF file, which can serve as a monitoring form for the individual, or in .XLS file format, which will export the data in an organized way to the interviewer can make calculations and analyzes with the exported data in other platforms.

Stage 3: Analysis

Stage 3 is where the interviewer will use the exported data. This step consists of two modules:

- Analysis: where the interviewer will analyze the exported data that can be assisted by an application or not; and

- Conclusion: where the interviewer after analyzing data, will give the feedback to the individual respondent.

V. RESULTS

The software application R24móvel was developed by the Interactive Educational Technologies in Health of the University of Brasilia - *Centro de Tecnologias Educacionais Interativas em Saúde da Universidade de Brasilia* (CENTEIAS/UnB). It aims to merge the process of data entry and the 24-hour recall data calculation, thereby decreasing the time spent in the process of obtaining food consumption data (application and calculation of food consumption data), improving process quality, and modernizing the methods in the nutrition area.

Figure 6. 24h Recall Result Screen.

All the screenshots in this work were extracted from the implementation of the R24móvel in a mobile Samsung Galaxy tablet, Android version 4.1. The application is used by the Nutrition Department of the University of Brasilia.

The application, in its first version, was subjected to a test validation, where 80 volunteers who answered three R24 recalls on paper and three using the R24móvel application, and a validation and usability test, in which 19 nutritionists answered the System Usability Scale questionnaire to obtain the usability and individual scores, the volunteers' characteristics is shown in Table 1.

Table 1 – Volunteers characteristics.

Characteristic	Womens		Men		Total	
	Mean	SD	Mean	SD	Mean	SD
Age (years)	24,9	7,9	25,6	9,5	25,2	8,6
BMI (kg/m²)	22,6	4,1	24,4	4,8	23,3	4,5
Years of schooling	14,0	2,2	14,8	2,0	14,3	2,1
	N	%	n	%	n	%
Civil Status:						
Single	39	79,6	26	83,9	65	81,3
Married	8	16,3	4	12,9	12	15,0
Divorced	2	4,1	1	3,2	3	3,8
Autoimmune disease:						
Don't have	44	89,8	27	81,7	71	88,7
Hypertension	0	0,0	2	6,5	2	2,5
Others	5	10,2	2	6,5	7	8,8

Tests were used to analyze the statistical data, such as the Multivalued Variance Analysis (MANOVA) test, Spearman correlation coefficient, quartile classification, kappa statistic and the Bland-Altman graphics.

The MANOVA results showed no differences between the averages obtained with the two instruments (p = 0.270 to 0.947). The correlation coefficients between the results of the application and the paper form ranged from 0.140 to 0.511 (p = 0.570 to < 0.000). In quartiles classification, all the nutrients, calculated in both instruments, were equally more than 65% of permanency in the same or adjacent quartile. The kappa statistics values ranged from -0.340 to 0.670. In Bland-Altman we did not observe a trend of overestimating or underestimating the data consumer application. The mean of R24 score of usability was 55.9 ± 17.4. The highest individual score was satisfactory (2.50 ±1.15) and the lowest was an efficiency of (1,87 ± 0,93) [12]. The individual scores of usability's principles, is shown in the Table 2.

The average time spent in the application and calculation of R24 was significantly greater in the paper form method compared to the app solution. In paper, the average was 17.8 ± 4.4 minutes and in the R24 mobile application the average time was 12.6 ± 3.2 minutes (p <0.001).

Table 2 – Usability's principle's individual score.

Principle	Mean	Maximum-Minimum
Learning facility	2,13 (±2,05)	0,68 - 3,58
Efficiency	1,87 (±0,93)	1,21 - 2,53
Memorizing facility	2,39 (±1,30)	1,47 - 3,32
Minimization of errors	2,28 (±2,26)	0,68 - 3,89
Satisfaction	2,50 (±1,15)	1,68 - 3.32

VI. CONCLUSION

The application, in its first version, was subjected to a test validation, where 80 volunteers who answered three R24 recall interview questions on paper and three using the R24móvel application.

In addition, a validation and usability test was carried out, in which 19 nutritionists answered the System Usability Scale questionnaire to obtain the usability and individual scores. Tests to analyze the statistical data were used, these being, the Multivariate Analysis of Variance (MANOVA) test, Spearman correlation coefficient, quartile classification, kappa statistic and the Bland-Altman graphics.

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REFERENCES

[1] NutWin. Avaliable in: http://www.unifesp.br/dis/produtos/nutwin/. Accessed in: February of 2014.

[2] Nutrisurvey. Avaliable in: http://www.nutrisurvey.de/. Accessedin: February of 2014.

[3] ASA24 The Automated Self-Administered 24-Hour Dietary Recall. Avaliable in: http://appliedresearch.cancer.gov/tools/instruments/asa24/. Accessedin: February of 2014.

[4] NutiMobile. Avaliable in: http://www.scortegagna.com.br/index.php/nutrimobile/. Accessedin: February of 2014.

[5] E. Moreira de Carvalho, J. R. Fernandes, Araujo, A.P.F., Holanda, M.T. ;Dullius, J. "Doce Desafio: Software to control and monitoring of type 1 diabetes in mobile devices". In: 2014 9th Iberian Conference on Information Systems and Technologies (CISTI), 2014, doi: 10.1109/CISTI.2014.6876892.

[6] F. E. Thompson, A. F. Subar, "Dietary Assessment Methodology," In: National Cancer Institute, Bethesda, Maryland

[7] L. B. Holanda, and A. A Barros Filho,"Applied methods in dietary assessment," Revista Paulista de Pediatria 2006; vol 24(1): pp. 62-70.

[8] R.W. Diez Garcia, "Representações sobre consumo alimentar e suas implicações em inquéritos alimentares: estudo qualitativo em sujeitos submetidos à prescrição dietética," Revista de Nutrição, vol.17 no.1 Campinas Jan./Mar. 2004 http://dx.doi.org/10.1590/S1415-52732004000100002.

[9] SQLite. Avaliable in: http://www.sqlite.org/. Accessedin: February of 2014.

[10] P. Pin-Shan Chen, The entity-relationship model—toward a unified view of data. Journal ACM Transactions on Database Systems (TODS) – Vol. 1 Issue 1, Março 1976 Pp. 9-36. Doi: 10.1145/320434.320440.

[11] TACO - Tabela Brasileira de Composição de Alimentos.Avaliable in:: http://www.unicamp.br/nepa/taco/. Accessedin: February of 2014.

[12] B.T. Souza, "Aplicativo de Recordatório 24 Horas Para Tablet: Desenvolvimento, Avaliação de Usabilidade e Validação Relativa do Método," Departamento de Nutrição, Faculdade de Ciências da Saúde, Universidade de Brásilia, 2014.