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Performance of the Brazilian version of GloboDiet software for dietary intake assessment

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Abstract

Background: GloboDiet is a software that conducts the interview of the 24-h dietary recall (24HR) guided by a standardized routine. The successful experience of adapting this software in different cultural contexts in Europe led to the extension of the project to Latin American countries. Brazil was one of the selected countries to start the project in collaboration with IARC, and a Brazilian version of the GloboDiet software was developed. Therefore, this study aimed to estimate food intake using the Brazilian version of GloboDiet software and compare whether there is concordance of the estimated intake of energy, carbohydrates, protein, and lipids between the GloboDiet and Nutrition Data System for Research—NDSR software.

Methods: We considered a sub-sample of 100 adult individuals from ISA-Capital 2008 survey, a population-based study of resident in the urban area of São Paulo, Brazil. We obtained dietary intake data through the 24HR using the NDSR software. In this study, the 24HR of the same 100 individuals were entered in GloboDiet software—Brazilian version. Then, statistical analyses were performed considering Bland and Altman analysis and Kappa statistic to evaluate the agreement between the software. It also used the terciles of energy and macronutrients.

Results: The mean (SD) obtained for energy, protein, carbohydrate, and lipids in the NDSR was 2386.47 (444.25) kcal, 100.08 (35.33) g, 286.75 (84.02) g, and 87.34 (28.32) g, respectively. In comparison, the SD obtained in the GloboDiet for those same variables was 2279.67 (655.50) kcal, 92.94 (38.35) g, 277.62 (93.86) g, and 83.12 (33.69) g, respectively. The mean (95% CI of agreement limits) of the differences between two measurements for energy, protein, carbohydrate, and lipids is 106.8 (− 961.3; 1174.9) kcal, 7.142 (− 58.6; 72.9) g, 9.1 (− 128.958; 147.208), and 4.2 (− 64.039; 72.489) g, respectively. From the Kappa statistic, we verified a slight and significant agreement ($p < 0.05$) considering the tertiles of energy and macronutrient between the software.

Conclusions: The Brazilian version of GloboDiet software seems to have a good performance when compared to NDSR software. However, further researchers are needed to validate the dietary intake from GloboDiet.

Keywords: Dietary assessment, GloboDiet, Computer software

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Background

The use of technology is a potential resource to help the estimation of food intake and data analysis in dietary studies. In addition, the technology provides data collection more accurate and less arduous [1–3]. Moreover, it allows high standardization in data collection, which is relevant, in special in multicenter and international studies [4].

Population surveys for nutritional surveillance have traditionally used the 24-h dietary recall (24HR) to measure diet, due to the details that can be obtained [5]. 24HR consists of defining and quantifying all foods and beverages consumed in the pre-interview period, usually the previous day [6, 7]. Before the use of personal computers, the information was collected on paper, but the technological advances led to the development of software that automated the process of the interview for the 24HR [8].

GloboDiet (GD) software is the result of the development of a standardized and computerized methodology for collecting individual food intake data through the 24HR interview. This software was developed by the IARC (International Agency for Research on Cancer, World Health Organization), initially named as EPIC-Soft software and after renamed to GloboDiet [9]. Recently, the software was adapted to harmonize methodologies for dietary intake assessment in studies conducted in most of Europe [10].

The successful experience of adapting the software in different cultural contexts in Europe led to the extension of the project to Latin American countries. IARC has proposed the *Latin America GloboDiet project* to provide a method of obtaining highly standardized data in Latin American countries considering the GloboDiet software and associated infrastructures as an initiative supported by the World Health Organization (WHO). Thus, Brazil was one of the countries selected to start the project in collaboration with IARC. Therefore, since 2013, the Brazilian version of the software has been developed.

In Brazil, the studies have used different software, especially those developed in other countries such as the Nutrition Data System for Research (NDSR), a program developed in the windows platform for dietary analysis through the collection and analysis of data obtained by 24HR from the University of Minnesota that provides data per ingredient, food, meal, and day in report and analysis file formats, such as nutrient levels [11]. In 2008–2009, the Brazilian Family Budgets Survey (*Pesquisa de Orçamentos Familiares—POF*) used the information from the Brazilian Table of Food Composition (*Tabela Brasileira de Composição de Alimentos*—TACO) and the food composition database from NDSR software for the analysis of dietary intake in Brazil [12]. Another Brazilian population-based study (São Paulo State Health Survey—ISA-Capital), a cross-sectional study analysis of the living conditions, health situation and use of health services, through home interviews, used the NDSR software to analyze the nutrients, foods, and meals [13].

The NDSR software has also been used in major international study such as the National Health and Nutrition Examination Survey (NHANES) [14]. In addition, the NDSR software led to the development of the Automated Self-Administered 24-h (ASA24®) in the USA, a tool created by the National Cancer Institute in 2009 to assess dietary intake through the 24-h recall [15].

Therefore, it is necessary to evaluate the performance of the Brazilian version of GloboDiet software compared to other software used to estimate food intake. Thus, this manuscript intends to estimate the dietary intake using the Brazilian version of GloboDiet software and to evaluate the agreement between the estimated consumption (energy, carbohydrates, proteins, and lipids) by GloboDiet software and the food consumption obtained in the Nutrition Data System for Research—NDSR.

Methods

Study population

It was considered a random sub-sample of 100 adults belonging to a representative sample of the population living in the urban area of the city of São Paulo, previously defined in another study "Population-based Health Survey in the County of São Paulo—ISA-Capital 2008" [16]. The same proportion of the variables gender, age, and smoking prevalence of the main study population was maintained for a sub-sample.

The information about demographic, socioeconomic, lifestyle (physical activity using International Physical Activity Questionnaire—IPAQ, dietary intake, smoking, and alcohol use), referred morbidity, historical family illness, use of supplements, and medicines was obtained at home.

Dietary assessment

In this study, the dietary intake was collected through the 24-h recall, being the first interview taken at the participant's home, and the second, by telephone. Both data of 24HR were entered in NDSR, but only the first one was considered for the agreement evaluation. The 100 recalls were entered in GloboDiet software—Brazilian version, and later, the results from energy, carbohydrate, protein, and lipid were compared with the results obtained in the NDSR software.

The Brazilian version of GloboDiet considers the 24HR interview, directed by a standardized script based on the translation, adaptation, and customization of approximately 70 databases, considering the standard operating procedures established internationally by the IARC

and the databases of existing national studies such as the "Brazilian Family Budgets Survey 2008-2009—POF 2008–2009" and "São Paulo State Health Survey—ISA-Capital". Now, there are 1746 foods consumed by the Brazilian population and classified into 18 groups with 86 classes and 50 sub-classes, and 380 recipes. The methodology used by the software can be structured in 5 steps (1—general information about the interviewer, interviewee, and the recalled day; 2—quick list; 3—quantification and description of food/recipes; 4—control at nutrient level; and 5—information on dietary supplements).

The GloboDiet has an internal table from nutrient data, and these values were obtained from POF's food composition database. However, the values should be used only for final control and national food composition database (FCDB) should be linked with food data from GloboDiet. The Brazilian' researches have been working to finalize the FCDB that will be linked. On the other hand, the Nutrition Data System for Research—NDSR (NDS, version 2007, Nutrition Coordinating Center—NCC, University of Minnesota, Minneapolis, MN) can estimate dietary intake from 24-h dietary recall, records, menus, and recipes. The software has a database with over 18,000 foods and 165 nutrients, nutrient ratios, and other components. The table of food composition from United States Department of Agriculture (USDA) is the main table that provides nutritional data. This software calculates nutrients consumed by ingredient, food, meal, and day and also evaluates the use of dietary supplements.

Statistical analysis

The prevalence of gender, age, body mass index, smoking, race, consumption of alcoholic beverages, and physical activity level were analyzed in the study sample. Daily energy, carbohydrates, proteins, and lipids were described using means, standard deviations (SD), 95% confidence intervals (95% CI), percentiles, minimum, and maximum.

The Kappa statistical analysis was used to evaluate the agreement of energy and macronutrient outcomes between NDSR and GloboDiet. Firstly, it calculated the tertiles of the energy, carbohydrate, protein, and lipid variables for each software; then, we estimated the percentage of agreement and the Kappa value. It was considered that values above 0.80 for the Kappa statistic mean an optimal agreement between the two software. For Kappa values between 0.61 and 0.80, there is a good agreement; 0.41 and 0.60, there is a moderate agreement; and 0.21 and 0.40, there is a slight agreement, and for values smaller than 0.20, there is a poor agreement among the software [17].

In addition, it also used the Bland and Altman analysis with graphics for each macronutrient and energy. The Bland and Altman model [18] is used to graphically represent the agreement between software. Thus, in the graph, i.e., scatter diagram, the x-axis represents the mean between the NDSR and GloboDiet software and the y-axis represents the difference between the measures of two software. Two continuous horizontal lines are shown at values that correspond to 95% confidence interval of agreement limits, and a dashed horizontal line is drawn in the mean of differences between the measures of the two software.

All statistical analyses were performed using the Stata software (StataCorp. 2013. Stata Statistical Software: Release 13. College Station, TX: StataCorp LP), and the level of significance considered was 5%.

Results

The mean age of the study population (100 individuals) was 39 years old, 52% were female, and the white color was self-reported by 61% of study sample. One third of the sub-sample was physically active (34%). Most of the individuals were considered overweight (57%), 74% reported not being smokers, and 63% of the sample did not drink alcoholic beverages (Table 1).

Table 2 shows the mean and the distribution of energy and macronutrients. The mean (standard deviation) obtained for energy, proteins, carbohydrates, and lipids in the NDSR software was 2386.47 (444.25) kcal, 100.08 (35.33) g, 286.75 (84.02) g, and 87.34 (28.32) g, respectively, while the mean obtained in the GloboDiet software was 2279.67 (655.50) kcal for energy, 92.94 (38.35) g for proteins, 277.62 (93.86) g for carbohydrates, and 83.12 (33, 69) g for lipids.

There is a good distribution among the energy data considering the difference of values calculated by the two software (Fig. 1). The mean (95% CI of agreement limits) of the differences between the two measures was 106.8 (– 961.3; 1174.9) kcal.

The distribution of macronutrient values (carbohydrates, proteins, and lipids) measured by the two software is shown in Fig. 2. There is also a good distribution of values for carbohydrates, and the mean (95% CI of agreement limits) of the differences between the two measures was 9.1 (– 128.958; 147.208) g. For proteins, the mean (95% CI of agreement limits) of the difference was 7.142 (– 58.6; 72.9) g, whereas for the fat, the mean difference was 4.2 (– 64.039; 72.489) g, which is the lowest mean when compared to the other macronutrients.

The Kappa statistic was performed to evaluate the agreement of the energy and macronutrient measures between the two software. The values ranged between 0.28 (energy and lipids) and 0.35 (proteins and

Table 1 The study population according to gender, age, body mass index (BMI), smoking, alcohol consumption, race, and level of physical activity

Characterization of the study population	*n*
Gender	
Male	48
Female	52
Age	
20–29 years old	31
30–39 years old	18
≥ 40 years old	11
Body mass index	
Underweight	4
Normal weight	38
Overweight and obesity	57
Smoking	
No	74
Yes	26
Alcoholic beverage	
No	37
Yes	63
Race	
White	61
Black	5
Mixed	33
Others (Asians/Indians)	1
Physical activity (level)	
Insufficiently active	18
Moderately active	23
Active	34
Vigorously active	24

carbohydrates). We observed a slight and significant agreement ($p < 0.05$) for all variables analyzed (Table 3).

Discussion

The mean values of energy and macronutrients, as well as their maximum and minimum values, calculated by the GloboDiet and NDSR software, did not appear to be very different. In the Bland-Altman graphs, there is a homogeneous dispersion of the data and a difference between the two methods close to zero, which means a good agreement between the methods. The concordance did not vary between energy, carbohydrates, proteins, and lipids considering the Kappa statistic, and the values showed that there was a slight and significant agreement between the two methods for energy and macronutrients.

We compared two software (NDSR and GloboDiet Brazilian version) that have different methodologies, but this difference is small, especially regarding the similarity in the structure of the software. Both software present a sequence of steps for the collection of the food intake data. The GloboDiet allows conducting the 24HR interview guided by a standardized script (menu) with a development approach to minimize collection errors and ensuring the high standardization in the application of the method [9]. The NDSR follows the structure of the Automated Multiple-Pass Method (AMPM) which has five main steps that guide the 24HR interview (quick list, food listing usually forgotten, meal and time of meal, review and cycle review, and final review), which also aim to minimize the error collection and greater standardization in the application of the method [13].

However, the NDSR software was developed based on foods and recipes that the average American citizen consumes, which is different from the foods and recipes that

Table 2 Distribution of energy, carbohydrates, proteins, and lipids obtained in NDSR software and GloboDiet software

	n	Mean	SD	95% CI		Min	Percentiles							Max
							5	10	25	50	75	90	95	
Energy (kcal)														
Software NDSR	100	2386.5	444.3	2298.3	2474.6	1764.9	1838.0	1883.4	2021.5	2254.7	2731.8	3029.7	3233.1	3459.3
Software GD	100	2279.7	655.5	2149.6	2409.7	1026.4	1239.6	1496.4	1846.6	2156.2	2774.1	3280.3	3548.4	3774.1
Proteins (g)														
Software NDSR	100	100.1	35.3	93.1	107.1	39.2	56.7	63.2	76.3	91.8	117.5	152.0	175.7	228.5
Software GD	100	92.9	38.4	85.3	100.6	37.3	43.5	50.2	61.7	88.1	112.7	146.1	177.9	197.9
Carbohydrates (g)														
Software NDSR	100	286.8	84.0	270.1	303.4	73.6	164.9	197.2	238.0	277.6	323.4	401.5	464.1	560.9
Software GD	100	277.6	93.9	259.0	296.3	89.7	135.6	170.4	212.9	264.7	334.8	434.1	455.6	535.5
Fat (g)														
Software NDSR	100	87.3	28.3	81.7	93.0	39.5	43.6	51.4	65.6	84.4	106.3	125.8	134.1	169.3
Software GD	100	83.1	33.7	76.4	89.8	23.7	38.3	42.3	59.5	79.3	101.0	132.7	149.0	184.1

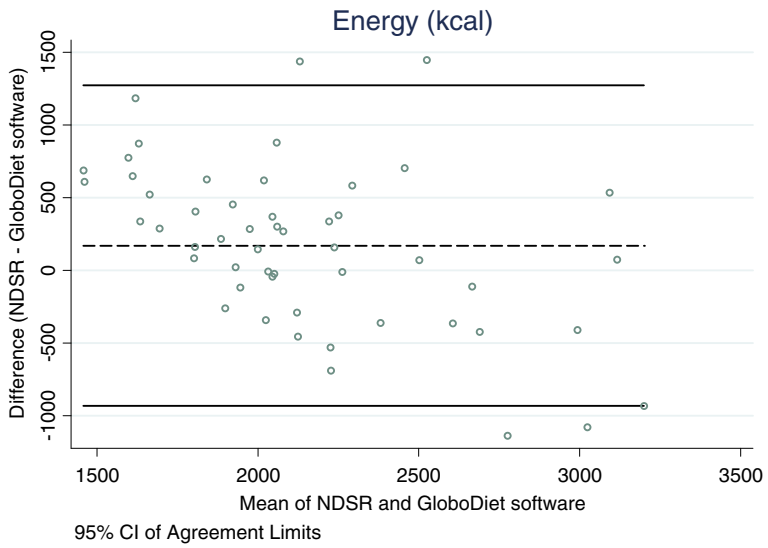

Fig. 1 Mean of 24HR and difference between the energy intake measured considering the NDSR and GloboDiet (GD) software

Brazilians usually eat, since each country has its own culture and food habits. An example of a traditional recipe that was included in the software is Feijoada, a dish that is not present in all different diets around the world. Thus, it is important to have a software for dietary intake assessment, such as GloboDiet Brazilian version, to have a better estimation of food consumption in Brazil, since it has more diversity in food composition regarding Brazilians eating patterns.

It should be noted that the evaluation of food intake is very important for the analysis of the health status of the population, and there is a complexity in measuring it. Thus, there is no method of evaluating food consumption that is considered perfect [19]. The ability of the interviewer to collect data can strongly influence the information obtained. The knowledge of the chosen methodology, the previous training, the adequate use of the techniques of inquiry, and the scientific rigor are items

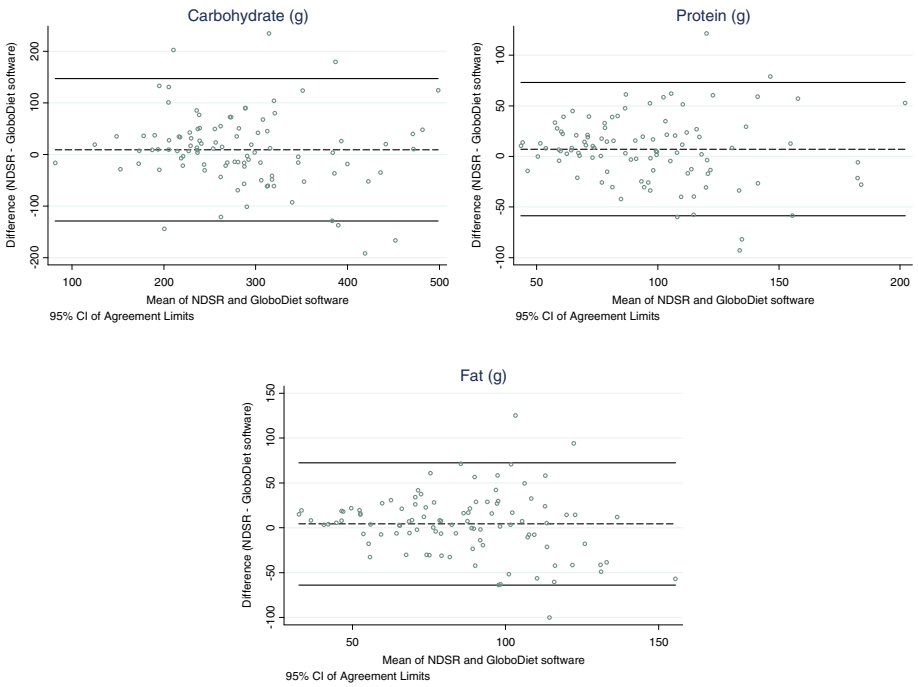

Fig. 2 Values of mean and difference in carbohydrates, protein, and fat intake measured by NDSR and GloboDiet (GD) software

Table 3 Frequency of agreement (%) and Kappa values of energy and macronutrients measures among NDSR software and GloboDiet (GD)

	Agreement (%)	Kappa value	*p* value
Energy (kcal)			
Software NDSR × software GD	52.00	0.28	0.000*
Protein (g)			
Software NDSR × software GD	57.00	0.35	0.000*
Carbohydrate (g)			
Software NDSR × software GD	57.00	0.35	0.000*
Fat (g)			
Software NDSR × software GD	57.00	0.28	0.000*

*$p < 0.05$ (statistic significant value)

that must be completed [20, 21]. So, software that improves the accuracy of dietary measure has been developed, such as GloboDiet Brazilian version.

The Brazilian version of GloboDiet software was supported by IARC and received financial support by CNPq. Its first version was completed at the end of 2016. The researchers developed the version with care. Approximately 70 food databases, recipes, food supplements, and quantification methods, common and specific to the country, were generated and/or adapted. We highlight the main adaptations: (a) list of food and recipes using local data based on their reported frequencies of consumption in national and/or regional dietary surveys; (b) list of household measures commonly used at home to estimate the volume of different portions (e.g., plates, several spoons, glasses, and cups); (c) a list of shapes to estimate the surface area and thickness (e.g., breads, cakes, pizza, and pies); (d) list of standard units are used for foods that exist in commercial units (e.g., yogurt, cookies, a can/bottle of soda, etc.); and (e) list of photos with different portion sizes were created [22].

Furthermore, the methodology includes the standardization of procedures for obtaining the 24HR interview, as well as the food databases and recipes considering the national studies such as the National Food Survey (e.g., "Pesquisa de Orçamentos Familiares 2008–2009" and "ISA-Capital 2008/2009"). Thus, the development of the software respected the culture and eating habits of the Brazilian population. In addition, there was a concern with the development and adaptation of the user's guide, manuals, and user training materials, facilitating the use of the software [22].

Some limitations were found in this study, such as the fact that the interviews were not collected directly in the software. The collection of 24HR was initially performed on paper and then typed in both software, which may have led to errors in the standardization of data collection, since software could better assist the interviewer considering the script/menu, in special, in the description and quantification of food. Furthermore, we need to report that the 1-day 24HR does not represent the usual intake but we did not have intention to estimate the usual intake. In addition, nutrient data were obtained from food composition which was elaborated for using in National Food Survey 2008–2009. However, these values should be used only for final control and national food composition database (FCDB) should be linked with food data from GloboDiet. Nowadays, Brazilians' researchers have been working to finalize the food composition database that will be used.

Besides that, it is recognized that new studies are needed to evaluate the performance of the Brazilian version of GloboDiet software as viability, validation, and reproducibility studies that they are expected for the coming months. In addition, another important study is already being conducted regarding the food composition table linked to the Brazilian version of the software. The methodology combines the dietary data of the GloboDiet software with the Ciqual Food Composition Table 2013 [23]. This study should consider four steps: (1) identification of equivalence between generic foods; (2) prioritization of facets of specific food items; (3) grouping of equivalent descriptors for each facet; and (4) connection between database and composition table. The decision regarding the equivalence in the nutritional composition of different food items will be guided by the criteria recommended by the International Network of Food Data Systems [24]. Thus, it is expected that the results of these other studies can be published assuring the quality of the information collected in this software.

Conclusion

The Brazilian version of GloboDiet software has a good performance when compared to NDSR software, which is widely used in the assessment of the dietary intake of several national and international studies. However, other studies are needed to evaluate the viability and validation of this version of GloboDiet software. So, in the future, it could be a software that will provide a more accurate measure of dietary intake in Brazil allowing comparison to international studies that use the same software for assessment of dietary intake.

Abbreviations

24HR: 24-h dietary recall; ASA24®: Automated Self-Administered 24-h; FCDB: Food composition database; GD: GloboDiet; IARC: International Agency for Research on Cancer; ISA-Capital: São Paulo State Health Survey; NDSR: Nutrition Data System for Research; NHANES: National Health and Nutrition Examination Survey; POF: Brazilian Family Budget Survey (*Pesquisa de orçamentos familiares*); SD: Standard deviations; TACO: Brazilian Table of Food Composition; USDA: United States Department of Agriculture; WHO: World Health Organization

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Availability of data and materials
The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Authors' contributions
RMF and DMLM designed the research. BSM and JS analyzed and interpreted the data. BSM, JS, and DML were major contributors in writing the manuscript. All authors read and approved the final manuscript.

Ethics approval and consent to participate
The study project was approved by the Ethics Committee at the School of Public Health, University of São Paulo (approval number: #2001). All participants were registered in the study after signing the consent forms at the beginning of the first visit.

Consent for publication
Not applicable

Competing interests
The authors declare that they have no competing interests.

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