Development of a quantitative food frequency questionnaire for Brazilian patients with type 2 diabetes

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Abstract

Background: To investigate the association between dietary components and development of chronic diabetic complications, the dietary evaluation should include a long period, months or years. The present manuscript aims to develop a quantitative food frequency questionnaire (FFQ) and a portfolio with food photos to assess the usual intake pattern of Brazilian patients with type 2 diabetes to be used in future studies.

Methods: Dietary data using 3-day weighed diet records (WDR) from 188 outpatients with type 2 diabetes were used to construct the list of usually consumed foods. Foods were initially clustered into eight groups: “cereals, tubers, roots, and derivatives”; “vegetables and legumes”; “fruits”; “beans”; “meat and eggs”; “milk and dairy products”; “oils and fats”, and “sugars and sweets”. The frequency of food intake and the relative contribution of each food item to the total energy and nutrient intakes were calculated. Portion sizes were determined according to the 25th, 50th, 75th, and 95th percentiles of intake for each food item.

Results: A total of 62 food items were selected based on the 3-day WDR and another 27 foods or how they are prepared and nine beverages were included after the expert examination. Also, a portfolio with food photos of each included food item and portion sizes was made to assist the patients in identifying the consumed portion.

Conclusions: We developed a practical quantitative FFQ and portfolio with photos of 98 food items covering those most commonly consumed in the past 12 months, to assess the usual diet pattern of patients with type 2 diabetes in Southern Brazil.

Keywords: Food frequency questionnaire, Type 2 diabetes mellitus, Food record, Epidemiologic methods

Background

The field of nutritional epidemiology has been developed because of an interest in the concept that aspects of diet may influence the occurrence of human disease [1]. In the case of patients with diabetes, dietary advice and assessment of compliance with these recommendations are important for achieving metabolic goals, especially glycemic control [2].

There are several methods for the assessment of food intake in nutritional epidemiology. The 24-hour recall, food records, food frequency questionnaire (FFQ), and biomarkers [3]. To investigate the association between dietary components and development of chronic diabetic complications, the dietary evaluation should include a long period, months or years, as is the case of FFQ. To date, four FFQs involving patients with diabetes have been validated and published in specific populations: Australian [4], Japanese [5], Malian [6], and Korean [7]; however, none was made for the Brazilian population. In fact, the FFQ should represent regional habits and the accuracy of such data needs to take this into account [8].

In drawing up an FFQ, careful attention must be given to the choice of foods, the clearness of the questions, and the format of the frequency response section. In
addition, the choice of foods, especially if the FFQ is constructed to also include quantitative or semi-quantitative dietary evaluation, should be based on an accurate dietary tool [9]. In this way, the present manuscript aims to create an FFQ and a portfolio with food photos to assess the usual intake pattern of Brazilian patients with diabetes to be used in future studies.

Methods

Study population
Patients were identified belonged to the Group of Nutrition in Endocrinology (GNE), a cohort of outpatients with type 2 diabetes in southern Brazil [10]. The GNE study was designed to evaluate possible associations of dietary factors with chronic complications of diabetes. From a previously constructed database of patients with type 2 diabetes [11] data from consecutive registered patients who reported a plausible ratio of protein intake estimated from the 3-day weighed diet records (WDR) to protein intake from urinary nitrogen [12] were selected. The acceptable ratio between the two protein intake estimates ranged from 0.79 to 1.26 [12]. An equal seasonal distribution (1:1:1:1 spring, summer, autumn, and winter) and the same gender proportion (1:1 males and females) between each season were also considered inclusion criteria. Therefore, records from 188 patients with type 2 diabetes were analyzed.

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving patients were approved by the Hospital Ethics Committee. Written informed consent was obtained from all patients.

The new instrument: food frequency questionnaire
The most frequently consumed foods and their respective portion sizes were extracted from 3-day WDR (two nonconsecutive weekdays and one-weekend day) to create the FFQ and the food portfolio photo. All registered foods and preparation methods were listed and clustered into eight groups as proposed by the Food Guide for the Brazilian Population [13]: “cereals, tubers, roots, and derivatives”; “vegetables and legumes”; “fruits”; “beans”; “meat and eggs”; “milk and dairy products”; “oils and fats” and “sugars and sweets”. The caloric and non caloric beverages were added into a new group, according to the WDR description (“beverages group”).

Data analyses
A food item was classified according to its relative contribution, at least 80%, for daily energy or intake of a selected relevant nutrient (K nutrient) in its respective

![Figure 1 Illustration of four portions of the same food (chayote cooked) photographed and included on the food portfolio.](image-url)
Table 2 Food list from food frequency questionnaire for diabetes: registered consumption frequency of 188 patients with type 2 diabetes and nutrient contribution

| Foods                        | Subjects consuming this food | Calories | Carbohydrate | Protein | Lipid | Fiber | Iron | Calcium | Potassium |
|------------------------------|------------------------------|----------|--------------|---------|-------|-------|------|---------|-----------|
|                              | n | %   |              |          |       |       |      |         |           |
| **Cereals, tubers, roots and derivatives** | | | | | | | | | |
| White rice                   | 177 | 94.1 | yes | yes | yes | no | yes | no | yes |
| French or Vienna bread       | 142 | 75.5 | yes | yes | yes | yes | yes | yes | yes |
| Spaghetti pasta              | 76  | 40.4 | yes | yes | yes | no | yes | no | yes |
| Wheat cracker                | 82  | 43.6 | yes | yes | yes | yes | yes | yes | yes |
| Whole bread                  | 78  | 41.4 | yes | yes | yes | yes | yes | yes | yes |
| Cassava, boiled              | 41  | 21.8 | yes | yes | no | no | yes | no | yes |
| Cake                         | 35  | 18.6 | yes | yes | no | yes | yes | no | yes |
| Maize porridge               | 23  | 12.2 | yes | yes | no | no | yes | no | yes |
| Potato, boiled/baked         | 82  | 43.6 | yes | yes | no | no | yes | no | yes |
| Homemade bread               | 24  | 12.7 | yes | yes | no | no | yes | no | yes |
| White bread                  | 35  | 18.6 | yes | yes | no | no | yes | yes | no |
| Milk cracker                 | 27  | 14.3 | yes | yes | no | yes | yes | no | yes |
| **Vegetables and legumes**   | | | | | | | | | |
| Carrot                       | 77  | 40.9 | no  | no  | no | no | yes | no | yes |
| Cabbage                      | 56  | 29.7 | no  | no  | no | no | yes | yes | yes |
| Tomato                       | 134 | 71.2 | no  | no  | no | no | yes | no | yes |
| Chayote                      | 34  | 18.0 | no  | no  | no | no | yes | no | yes |
| Lettuce                      | 112 | 59.5 | no  | no  | no | no | yes | yes | yes |
| Kale                         | 37  | 19.6 | no  | yes | no | no | yes | yes | yes |
| Broccoli                     | 22  | 11.7 | no  | no  | no | no | yes | no | yes |
| Pumpkin                      | 17  | 9.0  | no  | no  | no | no | no | no | yes |
| Beet                         | 20  | 10.6 | no  | no  | no | no | no | no | yes |
| **Fruits**                   | | | | | | | | | |
| Banana                       | 135 | 71.8 | yes | no  | no | no | yes | yes | no |
| Apple                        | 92  | 48.9 | yes | yes | no | no | yes | no | yes |
| Orange                       | 58  | 30.8 | yes | yes | no | no | yes | yes | yes |
| Tangerine                    | 51  | 27.1 | yes | yes | no | no | yes | no | yes |
| Papaya                       | 164 | 87.2 | yes | yes | no | no | yes | no | yes |
| Mango                        | 16  | 8.5  | no  | no  | yes | no | no | no | no |
| Pear                         | 19  | 10.1 | no  | no  | no | no | yes | no | no |
| **Beans**                    | | | | | | | | | |
| Beans (all types)            | 147 | 78.1 | yes | yes | yes | no | yes | yes | yes |
| Lentil                       | 16  | 8.5  | yes | yes | no | no | yes | no | yes |
| **Meat and eggs**            | | | | | | | | | |
| Beef, boiled/baked           | 122 | 64.8 | yes | no  | yes | yes | no | yes | yes |
| Chicken, boiled/baked        | 123 | 65.4 | yes | no  | yes | yes | no | yes | yes |
| Ground beef                  | 63  | 33.5 | yes | no  | yes | yes | no | yes | yes |
| Beef steak                   | 64  | 34.0 | yes | no  | yes | yes | no | yes | no |
| Luncheon/bologna             | 43  | 22.8 | yes | no  | yes | yes | no | yes | no |
| Fish, boiled/baked           | 21  | 11.1 | yes | no  | yes | yes | no | no | yes |
The relative contribution was calculated by the equation proposed by Block et al. [14] \[ \% \text{K nutrient contribution by food} = \frac{\text{amount of the K nutrient provided by food} \times 100}{\text{amount of the K nutrient provided by all foods}} \]. The most relevant nutrients in each food group were selected considering their influence on glucose metabolism [15-18] and/or diabetic complications [15,19-22] and are described in Table 1. Information about the nutritional composition of each food and regional ingredients used in their preparation was based on NutriBase Clinical® software (1986-2013 CyberSoft, Inc. an Arizona corporation). This software used the USDA Nutrient Database for Standard Reference [23]. Nutrient data on frequently consumed foods were complemented if necessary with data obtained from local manufacturers of specific industrialized foods.

The size of servings of each food item was classified according to its respective weight distribution as registered in the WDR: small = 25th percentile, medium = 50th percentile, large = 75th percentile, and extra large = 95th percentile [24]. Figure 1 shows an example of food portions as illustrated in the food portfolio photo. The amount of each portion in grams or milliliters was transformed into household measures using the Table for Assessment of Food Intake in Household Measures [25]. The FFQ also included open questions about the frequency of food consumption and an option to include new foods according to personal eating habits. The frequency was described as the number of times the food was consumed and also if the intake occurred daily, weekly, monthly, or yearly.

### Table 2 Food list from food frequency questionnaire for diabetes: registered consumption frequency of 188 patients with type 2 diabetes and nutrient contribution (Continued)

| Food                        | Frequency | Contribution | Daily | Weekly | Monthly | Yearly |
|-----------------------------|-----------|--------------|-------|--------|---------|--------|
| Pork                        | 28        | 14.8         | yes   | no     | yes     | no     |
| Fish, fried                 | 9         | 4.7          | yes   | no     | yes     | no     |
| Chicken, fried              | 14        | 7.4          | yes   | no     | yes     | no     |
| Frankfurter wiener, hot dog | 15        | 7.9          | no    | no     | yes     | no     |
| Mortadella                  | 35        | 18.6         | no    | no     | yes     | no     |
| Salmi                       | 23        | 12.2         | no    | no     | yes     | no     |
| Beef, fried                 | 8         | 4.2          | no    | no     | yes     | no     |
| Egg, boiled/fried           | 22        | 11.7         | no    | no     | yes     | no     |
| Beef liver                  | 6         | 3.1          | no    | no     | yes     | no     |
| Ham                         | 48        | 25.5         | no    | no     | yes     | no     |

**Milk and dairy products**

- Muenster cheese: 76, 40.4, yes no yes yes no no yes no
- Milk, fluid, 3.25% fat: 73, 38.8, yes yes yes yes no no yes yes
- Milk, fluid, nonfat: 78, 41.4, yes yes yes no no no no yes yes
- Goat cheese, soft type: 32, 17.0, no no no yes no no yes no
- Muenster cheese: 12, 6.3, no no no yes no no yes no
- Milk, fluid, 2% fat: 19, 10.1, no no no no no no no yes yes
- Yogurt, plain: 10, 5.3, no no no no no no yes no
- Milk type C: 10, 5.3, no no no no no no yes no
- Yogurt, plan, skim: 8, 4.2, no no no no no no yes no
- Milk, dry, whole: 10, 5.3, no no no no no no yes no
- Yogurt, fruit: 6, 3.1, no no no no no no yes no
- American cheese: 11, 5.8, no no no no no yes yes

**Oils and fats**

- Margarine: 101, 53.7, yes no no yes no no no no
- Goose pate: 23, 12.3, no no no yes no no no no
- Mayonnaise: 19, 10.1, no no no yes no no no no

**Sugars and sweets**

- Flan and/or pudding diet: 8, 4.2, no no no no no no yes no

*Nutrient contribution defined as contribution of at least 80% of total energy or relevant nutrient intake in the respective food group.*
| Food group                         | Small (25th) | Medium (50th) | Large (75th) | Extra large (95th) |
|-----------------------------------|--------------|--------------|--------------|-------------------|
| Cereals, tubers, roots, and derivatives |              |              |              |                   |
| White rice                        | 2 full tablespoon | 50 g         | 4 full tablespoon | 100 g            | 5 full tablespoon | 125 g | 8 full tablespoon | 200 g |
| Spaghetti pasta                   | 3 full tablespoon | 75 g         | 4 full tablespoon | 100 g            | 1 paten          | 200 g | 1 full paten      | 320 g |
| Cassava, boiled/fried             | 2 pieces     | 60 g         | 3 pieces      | 90 g             | 4 pieces         | 120 g | 6 pieces          | 240 g |
| Potato, boiled/baked/fried        | 2 full tablespoon | 60 g         | 3 full tablespoon | 90 g            | 4 full tablespoon | 120 g | 6 full tablespoon | 180 g |
| Maize porridge, boiled/fried      | 1 serving spoon | 60 g         | 2 full tablespoon | 90 g            | 3 full tablespoon | 150 g | 1 paten           | 325 g |
| French or Vienna bread            | ½ unit       | 25 g         | 1 unit        | 50 g             | 1 and ½ unit      | 75 g  | 2 units           | 100 g |
| White bread                       | 1 slice      | 25 g         | 2 slice       | 50 g             | 2 and ½ slices    | 62.5 g| 3 and ½ slices    | 87.5 g |
| Whole bread                       | ½ slice      | 15 g         | 1 slice       | 30 g             | 2 slices          | 60 g  | 3 slices          | 90 g  |
| Homemade bread                    | 2/3 slice    | 60 g         | 1 slice       | 68 g             | 1 and ½ slice     | 86 g  | 2 and ½ slices    | 145 g |
| Cake                              | 1 small slice | 50 g         | 1 medium slice | 70 g             | 1 large slice     | 90 g  | 2 medium slices   | 140 g |
| Wheat cracker                     | 4 units      | 20 g         | 6 units       | 30 g             | 9 units           | 45 g  | 20 units          | 100 g |
| Milk cracker                      | 5 units      | 25 g         | 8 units       | 40 g             | 11 units          | 55 g  | 32 units          | 160 g |
| Vegetables and legumes            |              |              |              |                   |
| Carrot                            | 2 full tablespoon | 24 g         | 3 full tablespoon | 36 g            | 5 full tablespoon | 60 g  | 10 full tablespoon | 120 g |
| Tomato                            | 3 small slices | 30 g         | 5 small slices | 50 g             | 7 small slices    | 70 g  | 7 medium slices   | 100 g |
| Chayote                           | 1 full tablespoon | 30 g         | 2 full tablespoon | 60 g            | 3 and ½ full tablet | 100 g | 5 full tablespoon | 145 g |
| Cabbage                           | 4 full tablespoon | 40 g         | 7 full tablespoon | 70 g            | 10 full tablespoon | 100 g | 6 full medium skimmer | 150 g |
| Lettuce                           | 1 tagger     | 20 g         | 2 taggers     | 30 g             | 5 medium leaf     | 50 g  | 1 full paten      | 80 g  |
| Watercress                        | 1 full dessert plate | 20 g         | 2 taggers     | 30 g             | 1 full paten      | 80 g  | 2 full patens     | 160 g |
| Kale, spinach                     | 2 full tablespoon | 40 g         | 3 full tablespoon | 60 g            | 5 full tablespoon | 100 g | 9 full tablespoon | 180 g |
| Broccoli, cauliflower             | 1 small bunch | 30 g         | 1 medium bunch | 60 g             | 1 large bunch     | 100 g | 2 medium bunches  | 130 g |
| Snap bean                         | 2 level tablespoon | 30 g         | 2 full tablespoon | 40 g            | 5 full tablespoon | 100 g | 15 full tablespoon | 300 g |
| Pumpkin                           | 1 medium piece | 50 g         | 2 medium pieces | 100 g           | 2 and ½ medium pieces | 125 g | 6 medium pieces   | 300 g |
| Beet                              | 2 medium slices | 30 g         | 5 medium slices | 60 g             | 8 medium slices   | 90 g  | 12 medium slices  | 140 g |
| Fruits                            |              |              |              |                   |
| Banana                            | 1 small unit | 40 g         | 1 medium unit | 70 g             | 1 large unit      | 90 g  | 2 medium units    | 140 g |
| Apple, pear                      | 1 small unit | 90 g         | 1 and ½ small unit | 135 g         | 1 medium unit     | 150 g | 1 large unit      | 230 g |
| Orange, tangerine                 | 1 small unit | 90 g         | 1 and ½ small unit | 135 g         | 1 large unit      | 180 g | 2 medium units    | 225 g |
| Papaya                            | ½ small slice | 80 g         | 1 medium slice | 100 g           | ¼ unit            | 135 g | ½ unit           | 270 g |
| Mango                             | 1 small piece | 60 g         | 2 small pieces | 120 g           | 1 medium pieces   | 140 g | 6 small pieces    | 360 g |
| Grape                             | 8 units      | 64 g         | 14 units      | 112 g            | 1 small bunch     | 170 g | 1 medium bunch    | 350 g |
| Persimmon                         | 1 small unit | 85 g         | 1 large unit  | 150 g            | 2 medium units    | 220 g | 3 small units     | 255 g |
| Casaba melon                      | ½ small slice | 78 g         | 1 small slice | 125 g           | 1 medium slice    | 200 g | 1 large slice     | 300 g |
| Watermelon                        | 1 small slice | 143 g        | 1 medium slice | 200 g           | 1 large slice     | 282 g | 2 medium slices   | 350 g |
| Beans                             |              |              |              |                   |
| Beans (all types)                 | 1 small full scoop | 65 g         | 1 level medium scoop | 80 g            | 2 small full scoop | 130 g | 2 level medium scoop | 160 g |
Table 3 Final food list in the food frequency questionnaire: portions in grams or milliliters and household measures

(Continued)

| Food Category                  | Portion Description | Portion in Grams | Portion in Milliliters | Portion in Household Measures |
|--------------------------------|---------------------|------------------|------------------------|-------------------------------|
| Lentil                         | 1 level medium scoop| 100 g            | 1 medium full scoop    | 160 g                         | 2 level medium scoop          | 200 g | 2 medium full scoop | 320 g |
| Meat and eggs                  |                     |                  |                        |                               |                                 |       |                   |       |
| Beef, boiled/baked/fried       | 1 small slice       | 70 g             | 4 small pieces         | 80 g                          | 1 large slice                 | 135 g | 2 large slices     | 270 g |
| Ground beef                    | 2 full tablespoon   | 50 g             | 3 full tablespoon      | 75 g                          | 4 full tablespoon             | 100 g | 8 full tablespoon  | 200 g |
| Beef steak                     | ½ small unit        | 40 g             | 1 small unit           | 80 g                          | 1 medium unit                 | 100 g | 2 medium units     | 200 g |
| Beef liver                      | ½ large unit        | 75 g             | 1 small unit           | 80 g                          | 1 medium unit                 | 100 g | 1 large unit       | 150 g |
| Chicken thigh, boiled/baked/fried| 1 medium piece | 60 g             | 1 large piece          | 95 g                          | 2 medium pieces               | 110 g | 3 medium pieces    | 180 g |
| Chicken breast, boiled/baked/fried| 1 medium piece | 60 g             | 1 large piece          | 95 g                          | 2 medium pieces               | 110 g | 3 medium pieces    | 180 g |
| Fish, boiled/baked/fried       | ½ small piece       | 60 g             | 1 small piece          | 100 g                         | 1 large piece                 | 155 g | 2 large pieces     | 310 g |
| Pork, boiled/baked/fried       | 1 small slice       | 60 g             | 1 medium slice         | 90 g                          | 1 large slice                 | 120 g | 2 medium slices    | 180 g |
| Luncheon/bologna               | ½ unit              | 30 g             | 1 unit                 | 60 g                          | 1 and ½ units                 | 90 g  | 2 and ½ units      | 150 g |
| Frankfurter wiener, hot dog    | 1 unit              | 42 g             | 1 and ½ unit           | 63 g                          | 2 units                       | 84 g  | 3 and ½ units      | 147 g |
| Mortadella, ham, salami        | 1 medium slice      | 15 g             | 1 large slice          | 25 g                          | 2 medium slices               | 30 g  | 2 large slices     | 50 g  |
| Egg, boiled/fried              | ½ unit              | 25 g             | 1 unit                 | 50 g                          | 1 and ½ unit                  | 75 g  | 3 units            | 150 g |
| Milk and dairy products        |                     |                  |                        |                               |                                 |       |                   |       |
| Milk, fluid, 3.25% fat         | ½ cup               | 100 ml           | ¼ cup                  | 150 ml                        | 1 cup                         | 200 ml | 1 mug             | 300 ml |
| Milk, fluid, 2% fat            | ½ cup               | 100 ml           | ¼ cup                  | 150 ml                        | 1 cup                         | 200 ml | 1 mug             | 300 ml |
| Milk, fluid, nonfat            | ¼ cup               | 150 ml           | 1 cup                  | 200 ml                        | 1 glass                       | 240 ml | 1 and ½ cups      | 250 ml |
| Milk, dry                      | 1 full tablespoon   | 16 g             | 2 full dessert spoon   | 18 g                          | 2 full tablespoon             | 32 g  | 4 full tablespoon  | 36 g  |
| Mozzarella cheese              | 1 slice             | 20 g             | 1 and ½ slice          | 30 g                          | 2 slices                      | 40 g  | 3 slices           | 60 g  |
| Ricotta cheese                 | 1 small slice       | 15 g             | 1 medium slice         | 35 g                          | 1 large slice                 | 45 g  | 2 large slices     | 90 g  |
| Muenster cheese                | 1 small slice       | 25 g             | 1 medium slice         | 35 g                          | 1 large slice                 | 50 g  | 2 medium large slices | 70 g  |
| Sour cultured, Cream half-half | 1 teaspoon          | 10 g             | 1 level tablespoon     | 15 g                          | 1 full tablespoon             | 25 g  | 4 level tablespoon | 60 g  |
| American cheese                | 1 level dessert spoon| 10 g            | 1 level tablespoon     | 15 g                          | 1 full tablespoon             | 30 g  | 2 full tablespoon  | 60 g  |
| Yogurt, plan                   | ½ pot               | 100 g            | 1 pot                 | 200 g                         | 1 and ½ pots                  | 300 g | 2 pots            | 400 g |
| Yogurt, fruit                  | 1 pot               | 100 g            | 1 and ½ pots          | 150 g                         | 2 pots                        | 200 g | 3 pots            | 300 g |
| Oils and fats                  |                     |                  |                        |                               |                                 |       |                   |       |
| Margarine                      | 1 level teaspoon    | 4 g              | 1 full teaspoon        | 8 g                           | 1 level dessert spoon         | 13 g  | 1 full dessert spoon | 23 g  |
| Butter                         | 1 level teaspoon    | 4 g              | 1 full teaspoon        | 8 g                           | 1 level dessert spoon         | 13 g  | 1 full dessert spoon | 23 g  |
| Mayonnaise                     | 1 full teaspoon     | 6 g              | 2 full teaspoon        | 12 g                          | 1 full dessert spoon          | 17 g  | 2 full dessert spoon | 34 g  |
| Goose pate                     | 1 full teaspoon     | 8 g              | 2 full teaspoon        | 16 g                          | 1 full dessert spoon          | 21 g  | 3 full dessert spoon | 63 g  |
| Oil, add                       | 1 teaspoon          | 2 ml             | 2 teaspoon            | 4 ml                          | 1 dessert spoon               | 5 ml  | 1 tablespoon       | 8 ml   |
| Sugars and sweets              |                     |                  |                        |                               |                                 |       |                   |       |
| Sago                           | 3 full tablespoon   | 90 g             | 4 full tablespoon      | 120 g                         | 5 full tablespoon             | 150 g | 6 full tablespoon  | 180 g |
| Chocolate                      | 2 pieces            | 15 g             | 3 pieces              | 30 g                          | 4 pieces                      | 40 g  | 8 pieces           | 80 g  |
| Flan, pudding                  | 1 full tablespoon   | 50 g             | 2 full tablespoon      | 90 g                          | 3 full tablespoon             | 130 g | 5 full tablespoon  | 220 g |
| Ice cream                      | 1 full tablespoon   | 55 g             | 1 ball                | 25 g                          | 1 cup                         | 100 g | 2 balls           | 150 g |

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In order to obtain an expert examination, the constructed FFQ was submitted to health researchers used to dealing with diabetes care: endocrinologists, nutritionists, and researchers from the GNE [10]. After the experts’ meeting, changes were made in the food list and definition of portion sizes. Regional dishes and seasonal foods were also included according to suggestions.

Portfolio with food photos

The construction of the portfolio with food photos was based on the methodology suggested by Monteiro et al. [26]. Digital photographs were taken of each portion of food from the FFQ and organized in the order in which they were mentioned, considering the four portion sizes and food groups (Figure 1). A numerical legend was also created to explain details about each portion (amount in grams or milliliters) and keep patients blinded to serving sizes. The solid foods were arranged in the same plate meal size to perform the pictures, in order to help the patients acquire a perspective of size.

Results

The main features of 188 patients with type 2 diabetes were: 61.1 ± 10.1 years of age (range 34-80 years), males 50.0%, 12 years (6-18 years) of diabetes duration, BMI of 28.8 ± 4.3 kg/m²; HbA1c of 7.5 ± 1.4%, 42.5% from lower middle class, and 84.4% self-identified as whites. The patients performed 3-day WDR, totaling 564 WDR during all seasons: 25% (n = 141) in winter, 25% (n = 141) in spring, 25% (n = 141) in summer, and 25% (n = 141) in autumn. Initially, a list of 177 different food items was compiled based on data from the WDR and the number of food items in each food cluster was as follows:

- “cereals, tubers, roots, and derivatives” - 39 food items;
- “vegetables and legumes” - 34 food items;
- “fruits” - 22 food items;
- “beans” - 5 food items;
- “meat and eggs” - 27 food items;
- “milk and dairy products” - 14 food items;
- “oils and fats” - 7 food items;
- “sugars and sweets” - 16 food items;
- “beverages” - 13 food items.

Subsequently, only 62 food types were included in the FFQ, considering the 80% cutoff contribution in its respective food group. The reported frequency of each included food item with respective relevant nutrient is shown in Table 2. The most frequently consumed foods by patients with diabetes included white rice (94.1%), papaya (87.2%), beans (78.2%), French or Vienna bread (75.5%), banana (71.8%), and tomato (71.3%). Furthermore, another four food items (lettuce, beef, chicken, and margarine) were reported by more than 50% of this patient sample. After expert examination, 21 regional foods (fruits, vegetables, sweets, and fats), six different types of food preparations, and nine beverages were included in the food list. The final version of the FFQ consisted of 98 food items and beverages distributed into nine groups: eight food groups and one of beverages. The preparation options (fried, boiled, cooked or roasted) were considered in food items of the “cereals, tubers, roots, and derivatives” and “meats and eggs” groups. The FFQ is shown in Additional file 1. All included food

| Table 3 Final food list in the food frequency questionnaire: portions in grams or milliliters and household measures (Continued) |
|---------------------------------------------------------------|
| Gelatin | 2 full tablespoon | 50 g | 3 full tablespoon | 75 g | 5 full tablespoon | 125 g | 12 full tablespoon | 300 g |
| Condensed milk | 1 level teaspoon | 10 g | 1 level dessert spoon | 15 g | 1 full tablespoon | 40 g | 2 full dessert spoon | 50 g |
| Jelly | 1 full teaspoon | 10 g | 2 full teaspoon | 20 g | 1 full tablespoon | 34 g | 2 full tablespoon | 68 g |
| Honey | 1 dessert spoon | 10 g | 1 tablespoon | 15 g | 2 dessert spoon | 20 g | 2 tablespoon | 30 g |
| Chocolate, dry | 1 level dessert spoon | 7 g | 1 level tablespoon | 11 g | 1 full tablespoon | 16 g | 2 full tablespoon | 32 g |

Beverages

| Coffee, brewed | ¼ cup | 50 ml | ½ cup | 100 ml | ¼ cup | 150 ml | 1 cup | 200 ml |
| Coffee, instant | 1 teaspoon | 15 g | 2 teaspoon | 30 g | 3 teaspoon | 45 g | 6 teaspoon | 90 g |
| Tea | ¼ cup | 150 ml | 1 cup | 200 ml | 1 and ¼ cups | 250 ml | 1 mug | 300 ml |
| Soft drink | 1 cup | 200 ml | 1 full glass | 250 ml | 1 can | 350 ml | 2 full glass | 500 ml |
| Fruit juice raw | ¼ cup | 150 ml | 1 cup | 200 ml | 1 full glass | 250 ml | 2 cups | 400 ml |
| Fruit juice artificial | ¼ cup | 150 ml | 1 cup | 200 ml | 1 full glass | 250 ml | 2 full glass | 500 ml |
| Soymilk | ¼ cup | 150 ml | ½ glass | 175 ml | 1 cup | 200 ml | 1 full glass | 250 ml |
| Beer | 1 glass | 300 ml | 1 bottle | 600 ml | 1 and ½ bottles | 900 ml | 6 bottles | 3600 ml |
| Wine | ½ glass | 75 ml | ¼ glass | 115 ml | 1 glass | 150 ml | 2 glass | 300 ml |
items contributed 95% of the total energy and nutrient intake as follows: total energy (94.2%), protein (96.8%), carbohydrate (92.8%), fat (94.6%), fiber (90.3%), iron (93.4%), calcium (95.3%), and potassium (92.2%). The portions of each food in grams or milliliters and its respective number of portions in household measures are shown in Table 3.

The FFQ also included open questions about frequency of food consumption and eight queries about food preferences and usual dietary practices: number of meals per day, type of sweetener added in beverages, type and amount of fat used in food preparation, if intake of visible fat from meats, the habit of salt added in prepared foods and salads, and other foods and/or seasonings not listed but regularly consumed.

Discussion
Patients with diabetes are encouraged to comply with specific dietary recommendations to achieve optimal glucose, lipid, and blood pressure control as well as a healthy body weight [2]. These aspects can modify the food intake of patients with diabetes as compared to the general population. We constructed a quantitative FFQ and a portfolio with photos of 98 food items distributed into nine food groups and based on WDR performed by patients with type 2 diabetes. This is the first FFQ for Brazilian type 2 diabetes patients.

The development of an FFQ should take into account some important aspects such as drawing up the food list, definition of portion intake [8], and how representative of the dietary habits of a population-based sample is the food list [1]. Our FFQ took into account the foods most commonly consumed by patients with type 2 diabetes and, as recommended, represents the regional dietary habits [1] in Southern Brazil. In addition, the cultural and clinical appropriateness of food items included in our FFQ was assured by using as reference the 3-day WDRs, a dietary instrument previously standardized, validated [12,27], and widely used in diabetic patients by our research group [11,28-30]. It is also important to keep in mind that these WDR were performed throughout the year because it is known that portion sizes and food types can vary according to season [31] and the gender distribution was equal, since gender also influences food intake [31].

The final food list was drawn up considering the contribution criteria of each relevant nutrient to minimize the omission of usually consumed food [14]. It should be noted that nutrients known to influence glucose, lipid, or blood pressure control, or that have been associated with chronic diabetic complications were considered to choose the relevant nutrients for the food list. The number of food items in the final version of the FFQ is appropriate according to suggestions found in the literature [32] and similar to other FFQs for diabetes around the world [5-7]. Small food lists (less than 50 items) may underestimate food intake, and very long lists (more than 100 items) may tire respondents and overestimate food intake [32].

The FFQ in the present study also includes a quantitative evaluation of food intake. The size of portions (quartiles of intake) was based on the weight of consumed foods assessed by 3-day WDR. These portions, specific for each food item, were shown as photos and as household measures in the food portfolio and can be easily used for respondents to select their own portion size [8]. Finally, the FFQ structure including open questions provides greater freedom to choose the actual frequency of food intake and reduces the error of consumption categories by the patients [32]. The frequency of food consumption was considered in this FFQ (day, week, month, or year). However, care should be taken when assessing the consumption of a particular food per year. The diary conversion of intake is necessary to minimize the contribution of the foods scarcely consumed in evaluating the eating habits of the individual [8].

Conclusions
In conclusion, we developed a practical quantitative FFQ and a portfolio with 98 food items covering the past 12 months and representing the usual food intake of patients with type 2 diabetes in Southern Brazil. This relatively long-term evaluation of food intake can be particularly relevant for prospective studies that evaluate associations of diet with chronic diabetic complications. However, this dietary instrument should be validated in other samples of patients.

Additional file

Additional file 1: Food frequency questionnaire developed for Brazilian patients with type 2 Diabetes.

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

Authors’ contributions
RAS was responsible for the study design, collection, analysis and interpretation of data, as well as the preparation of the manuscript. BPR contributed the construction of the portfolio with food photos. TCR contributed the initial idea. MJA contributed to the interpretation of results and final version of the manuscript. JCA contributed to the study design and each step of the FFQ construction as well as proof-reading the manuscript. The final paper version was approved by all authors.

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