



Review

Food consumption and glycemic testing of adults and elderly diabetic patients from Public Health: A systematic review of assessment methods

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ABSTRACT

Aims: To map and discuss the different methods used to assess food consumption and glycemic testing of adults and elderly diabetic patients from Public Health.

Materials and methods: A total of 710 records were identified by searching databases integrated by the Virtual Health Library website, between September and October 2017. The Newcastle Ottawa scale was used for study quality assessment. A total of 8 studies met inclusion criteria for analysis. Study characteristics were extracted and synthesized to generate comparisons.

Results: Food consumption was evaluated by Food Frequency Questionnaire, 24-hour Dietary Recall, Eating Attitudes Test (EAT-26), Questionnaire On Eating and Weight Patterns (QEWP-R), and questioning the salt intake. Glucose testing methods included Postprandial Glucose, Glycated Hemoglobin (HbA1C), fasting glucose, and self-reported diabetes.

Conclusions: Most methods that assess food consumption use single questionnaires, which are easy to administer and yield easily interpreted results. For glycemic testing, the majority used are conventional methods.

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1. Introduction

Diabetes Mellitus (DM) is a problem of great relevance in Public Health because it causes high rates of morbidity and mortality, resulting in a significant loss of patient's quality of life, productivity, and survival [1–3]. In several countries, Public Health centers are responsible for integrating health services that aim to provide universal access to medical and primary care [4,5]. In Public Health and other medical settings, DM involves great economic and social costs for its treatment and attention to its complications. For example, in 2005 DM caused 5.0 million deaths, and cost between USD 673 billion and USD 1197 billion in healthcare spending [3,6,7].

Decreased consumption of healthy foods, and increased consumption of sugars and saturated fats have become the main risk factors for the rising of obesity, Type 2 Diabetes Mellitus (DM2),

cardiovascular disease, and other common chronic diseases in adult and elderly patients [8,9]. The increased occurrence of these diseases instigates many specialists in Public Health and nutrition education to use several methods to verify the glycemia and eating behaviors of the population [10,11]. Various assessment methods have been used in different contexts, with different purposes and adjustments. Patients' health characteristics and sociodemographic conditions are among factors determining the method chosen [12].

The principles for diagnosis and classification of DM in adults and elderly do not differ greatly from the principles established for younger individuals [13]. However, it is necessary to know and consider aspects that differentiate this population from the other age groups, regarding treatment and assessment methods, including the verification of food intake [14] and glycemia [13,15]. Due to the relationship between abnormal dietary patterns and

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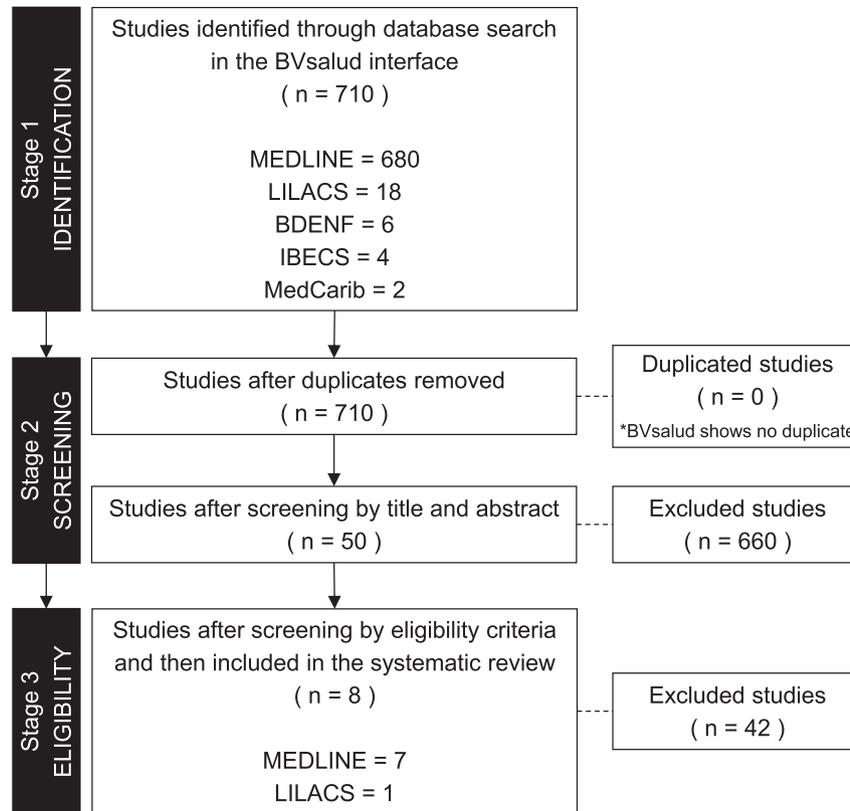


Fig. 1. Flow diagram of systematic review selection process (adaptation of the PRISMA diagram [22]).

DM, several studies have been conducted to evaluate the frequency of eating disorders, as well as their influence on the glycemic control of diabetic patients [16].

Given the importance of nutritional therapy for improving health and quality of life in the DM treatment, it is necessary to assess and evaluate the dietary habits and glycemic outcomes. To evaluate nutritional therapy, it is important to know what are the methods used to assess these characteristics in adults, as well in elderly [17]. Moreover, with the large investments that government agencies make to maintain Public Health [18–21], new studies become significant to map strategies and characteristics of the methods used.

From this context, we systematically reviewed the literature to map and discuss assessment methods of food consumption and glycemic testing used within adult and elderly diabetic patients from Public Health.

2. Methods

We performed a systematic literature review according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) report [22] merged with others guidelines [23,24].

2.1. Key questions

This study had three key questions:

- Key Question 1. Which studies address the food consumption of adult and elderly diabetic patients from Public Health?
- Key Question 2. What are the food consumption assessment methods used in Public Health?

- Key Question 3. What are the glycemic testing methods used in Public Health?

2.2. Search strategy

We consulted synonyms in DeCS [25] structured vocabulary service (NLM MeSH, 2017). By the PICO strategy, the search string was: ((aged OR elderly OR older adult OR adult) AND (food consumption OR eating OR food intake OR meal) AND (diabetes OR diabetes mellitus OR diabete OR diabetic) AND (public health OR primary healthcare OR healthcare)).

We performed the search in databases grouped through Virtual Health Library (BVsalud) website, including MEDLINE, LILACS, BDEFN, IBECs and MedCarib. We considered studies published from 2007 until 2017. There were no restrictions regarding language.

2.3. Eligibility criteria

We included studies: (I) that involved elderly over 60 years old and diagnosed with DM in its population; (II) performed within Public Health; (III) that used surveys to assess food consumption; (IV) that used method to check blood glucose; (V) that all enrolled subjects were over 18 years old. We used the Newcastle-Ottawa scale [26] for study quality assessment. All the included studies achieved 5–9 stars. We excluded review articles, letters, editorials, thesis, comments and discussion papers.

2.4. Studies selection process

The studies selection process was structured in three stages:

- Stage 1. Identification: search string executed in BVsalud website;
- Stage 2. Screening: publications title and abstract reviewed as a preliminary examination to determine if they contained information relevant to the key questions;
- Stage 3. Eligibility: studies evaluated with a full reading to settle their adequacy to the eligibility criteria, culminating in the included studies.

Two researchers simultaneously and independently performed the selection process, arranging the papers with Mendeley software (Mendeley Ltd, 2017) [27]. Evaluations with identical results were maintained, while divergent evaluations underwent a new analysis conducted jointly by the two researchers to reach the final consensus decision.

3. Results

The systematic review identified 710 papers in the surveyed databases. At first, 660 were excluded for not presenting affinity with the key questions in their titles and abstracts. With an appraisal of the full-text papers against the eligibility criteria, 42 studies were excluded, resulting in 8 papers included in this study (Fig. 1).

Given the results, it is possible to analyze answers to each key question. The details summary of the reviewed studies is presented in Table 1.

3.1. Key question 1: which studies address the food consumption of adult and elderly diabetic patients from Public Health?

The studies found were conducted by Winkelmann and Fontela [28], Kirii et al. [29], Dekker et al. [30], Oba et al. [31], Hsiao et al. [32], Nicolau et al. [33], Qiao et al. [34], and Chacko et al. [35]. Research characteristics and quality ratings for each study are displayed in Table 1. The locations of the studies in Public Health were Basic Health Units (n = 1), Support Groups (n = 1), and Clinical Centers (n = 6). Among the countries of the studies are Japan (n = 2), United States (n = 3), Netherlands (n = 1), Brazil (n = 1), and Spain (n = 1).

3.2. Key question 2: what are the food consumption assessment methods used in Public Health?

Food consumption was evaluated by several Food Frequency Questionnaires (FFQ), 24-hour Dietary Recall (24-h recall), Eating Attitudes Test (EAT-26), Questionnaire On Eating and Weight Patterns (QEWPR), and questioning the salt intake.

In the study by Winkelmann e Fontela [28], the dietary habits were evaluated in relation to the amount of salt consumed for a low sodium diet, with only Yes/No questions. This method does not identify the foods and frequency of consumption.

Kirii et al. [29] applied a Food Frequency Questionnaire, including 147 foods and beverages with standard portions and frequency of consumption. This questionnaire included questions

Table 1
Details of the studies with assessment methods of food consumption and glycemic testing used within adults and elderly diabetic patients from Public Health.

Study	Year of Publication	Origin	Population (N)	Patients' Age	Application in Public Health			Patients		Diabetes Mellitus Type	Dietary Assessment Method				Glycemic Testing Method			Other Characteristic Assessed						
					Basic Health Units	Support Groups	Clinical Centers	Men	Women		Type 1	Type 2	Food Frequency Questionnaire	24-hour Dietary Recall	Eating Attitudes Test (EAT-26)	Quest. on Eating and Weight Patterns (QEWPR)	Questioning the Salt Intake	Glycated Hemoglobin (HbA1c)	Fasting Glucose	Self-reported Diabetes	Body Mass Index (BMI)	Waist Circumference	Hip Circumference	Family Health History
Kirii et al. [29]	2009	Japan	1.114	40 – 69		✓		✓	✓		✓	✓					✓				✓	✓		
Chacko et al. [35]	2010	United States	3.713	50 – 79		✓			✓		✓	✓					✓	✓		✓	✓	✓		
Hsiao et al. [32]	2013	United States	449	Over 75			✓	✓	✓				✓				✓	✓	✓				✓	✓
Oba et al. [31]	2013	Japan	64.633	45 – 75			✓	✓	✓		✓	✓						✓	✓			✓	✓	✓
Qiao et al. [34]	2014	United States	161.808	50 – 79			✓		✓	✓	✓	✓						✓	✓			✓	✓	
Winkelmann and Fontela [28]	2014	Brazil	219	30 – 75	✓			✓	✓		✓					✓		✓				✓	✓	✓
Nicolau et al. [33]	2015	Spain	320	Unspecified (only averages)			✓	✓	✓				✓	✓			✓	✓	✓	✓			✓	✓
Dekker et al. [30]	2016	Netherlands	3.776	18 – 70		✓		✓	✓		✓	✓					✓	✓	✓	✓			✓	

about 147 food and beverage items with standard portions/units and eating frequency. Nine response options were available for eating frequency.

Dekker et al. [30] used data from 24-h recall to develop and apply FFQs in a variety of ethnic minority groups in Amsterdam. Food items were selected according to their percentage contribution to the variance in absolute nutrient intake related to the risk of cardiovascular disease and DM2 of the respective ethnic groups.

Oba et al. [31] applied an FFQ containing 147 items to evaluate usual diets. The evaluation was performed calculating the values of food glycemic index present in the FFQ.

Hsiao et al. [32] applied a 24-h recall through telephone interviews over a 10-month period. Foods were categorized into 29 food groups based on similarity of nutrient composition.

Nicolau et al. [33] used Eating Attitudes Test-26 (EAT-26) and Questionnaire on Eating and Weight Patterns (QEWP-R). EAT-26 is composed of 26 questions describing eating attitudes and behaviors, assessing factors related to Dieting, Bulimia, Food Preoccupation, and Oral Control [36]. QEWP-R is composed of 28 items that assess the presence and frequency of binge eating [37].

In the study by Qiao et al. [34], the participants completed an FFQ developed to estimate the average daily nutrient intake. Food quality was calculated based on food and nutrients derived from FFQ, including consumption of fruits, vegetables, legumes, the proportion of white meat to red meat, cereal fiber, trans fats, polyunsaturated and saturated fat, use of multivitamins, and supplements.

Chacko et al. [35] used a semi-quantitative FFQ to evaluate food and nutrient intake over a three-month period. All dietary nutrient variables were adjusted for total energy intake using the residual method. Intake of carbohydrate, protein, fat, dietary fiber, and magnesium were evaluated.

3.3. Key question 3: what are the glycemic testing methods used in Public Health?

Glucose testing methods included Glycated Hemoglobin (HbA1C), fasting glucose, and self-reported diabetes. Winkelmann and Fontela [28], as well as Kirii et al. [29], used the measurement of fasting glucose. In the studies of Dekker et al. [30], Hsiao et al. [32], and Nicolau et al. [33], fasting glucose concentrations were used jointly with HbA1c measurements. The authors justify that fasting glucose concentrations reflect the current or short-term state of glucose homeostasis, while HbA1c reflects blood glucose concentrations over a long period. In the studies of Oba et al. [31], Qiao et al. [34], and Chacko et al. [35], the patients were asked about the presence or absence of diabetes. However, this may not be an effective technique because it depends on patient's disposition, which may reports information inaccurately.

4. Discussion

With a mapping of the different approaches and assessment methods from the studies, it is useful to analyze the properties of each method applied, in addition to known methods that were not applied.

Regarding gender, the studies of Qiao et al. [34] and Chacko et al. [35] evaluated only menopausal women, differing from other studies that evaluated both men and women. All studies evaluated patients with DM2, and only one study evaluated DM1 along with DM2. There is a greater concern of the researchers regarding prevention of DM2, since this is usually a result of poor eating habits and inadequate lifestyle [38]. All the studies inquired about the use of cigarettes by participants. This information is important because smoking is harmful to DM, and it is also one of the main triggering

factors of the disease [39,40].

Food consumption assessment methods from the studies can be divided into 2 groups: prospective and retrospective. Prospective methods were used to assess the current food intake with food records and reminders. Retrospective methods, such as FFQ and 24-h recall, were used in population groups to associate food consumption with some illness [12].

FFQ was applied in 5 studies, showing that this is a recurrent assessment method, and it is also easy to apply, understand, and do not require expertise. It is the most practical of the methods, but there is distrust about its merits, given the possible errors in information's accuracy [41,42]. Nevertheless, FFQs had very different characteristics between the studies, demanding further research for its analysis.

EAT-26 and QEWP-R are well-known methods with proven ability, especially on DM subject [13,37,42], but poorly addressed among the reviewed studies. The 24-h recall was applied in only one study. This method identifies all foods eaten in the pre-interview period, usually the day before [43]. A useful assessment method, but not applied by any study, is the Dietary History, an interview about past eating habits. Its advantage is the description of the usual diet, in which the day-to-day variations are eliminated [41], indicating relevant data (e.g., number of daily meals, place of meals, appetite, preferences and aversions, use of supplements) [44]. Both 24-h recall and Dietary History are accessible methods because can be applied to illiterate people [12,41].

Regarding others nutritional assessments, all authors performed the body mass index (BMI) measurement because it is easy to obtain and facilitates effective results without high costs [45]. BMI provides better results if it is associated with other measures, such as Waist Circumference and Hip Circumference, performed in 3 and 1 of the reviewed studies, respectively. In an associated manner, these measures present a better anthropometric evaluation, considering that their correlations are parameters for risk evaluation of DM, cardiovascular, and other chronic diseases [45,46]. Measures that were not explored by the reviewed studies are the arm circumference and the abdomen circumference. These measures could have been useful, since they would indicate the percentage of body fat, a factor that influences DM development [13].

The family health history was surveyed in only 5 studies. Considering that DM can be hereditary [13], the evaluation of this history could have been better explored by the studies. Only 4 studies correlated DM with some common comorbidities (e.g., systemic arterial hypertension, heart and respiratory diseases, dyslipidemia, obesity, vascular disease, retinopathy, nephropathy, and neuropathy). When associated with other diseases, DM usually modifies patients' diet [13,47,48] and, therefore, all studies should have assessed the occurrence of comorbidities.

Glycemic testing methods are essential to control and understanding of adjustments in DM management [13,49]. One of the most used methods was fasting blood glucose, applied in 5 studies. Although widely recognized, this measure as a unique reference value is inefficient because it reflects an isolated glucose measure, which can easily change at other times, such as during meals. A more efficient way to manage DM is to associate the measurements taken at various times throughout the day, especially after meals [13]. Postprandial glucose enables the evaluation of postprandial hyperglycemic peaks, associated with effects of food intake, cardiovascular risk, and oxidative stress. However, no study performed postprandial glucose measurements.

HbA1c was performed in only three studies. This test enables the assessment of glycemic control over a longer period of about 12 weeks. HbA1c is recognized as one of the criteria for the DM diagnosis, besides being a benchmark globally employed [13].

A more modern method is the Continuous Glucose Monitoring

system (CGM). It employs a sensor to measure glucose in the interstitial fluid continuously [13]. Although CGM is a very useful method, it is still not very popular, especially for patients from Public Health. This method was not used in the reviewed studies, probably because it is a relatively recent method and requires considerable financial investment.

Another glycemic testing method is the Fructosamine, which measures the glycation of serum proteins, indicating glycemic control over the preceding 3–4 weeks [50]. Fructosamine is examined when the reliability of HbA1c dosage is compromised, such as in cases of anemia and hemoglobinopathies [13,51]. However, no study applied Fructosamine test, which may be an alternative for future studies on the subject.

5. Limitations

We used specific search terms, which may not have captured all the papers on the subject matter. We grouped in the same category the FFQs from the reviewed studies, even though they have different items and sizes. This study details only methods, without emphasis on how many times they were used, the sample size and the studies' duration.

6. Conclusions

We identified 8 studies demonstrating the different assessment methods of food consumption and glycemic testing of adults and elderly diabetic patients from Public Health. Our review presents a mapping of the researched scenario, providing a basis for future research related to the subject matter.

In Public Health, as well in others settings, patients have difficulty in the DM treatment, which requires care of several factors, and adequate food intake is a central factor for maintaining health and life quality. In this sense, understanding the available assessment methods and the circumstances in which they are applied could be useful in the adoption of strategies for similar settings and purposes.

The characteristics of food consumption assessment methods are influenced by regional, socioeconomic and cultural differences. Most methods employ single questionnaires, which are easy to administer and yield easily interpreted results. Food Frequency Questionnaire (FFQ) is the most used among studies, due to its rapid application and achievement of results easy to interpret. For glycemic testing, the majority used are conventional methods. Self-Reported Diabetes, a rudimentary method is still in use. Modern methods, such as continuous glucose monitoring, are not employed so far.

It is imperative to develop new mappings on studies conducted in other settings, such as private centers, and with other populations, such as children. These mappings can be compared with this study to visualize and inspect variations and similarities between the methods used in diverse situations.

Conflicts of interest

Authors declare no conflict of interest.

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