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# Validity and reproducibility of an interviewer-administered food frequency questionnaire in Austrian adults at risk of or with overt diabetes mellitus<sup>☆</sup>



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## ABSTRACT

Food frequency questionnaires (FFQs) provide an inexpensive tool for dietary assessment. Given the scarcity of data on their validity for nutritional analysis in persons with overt diabetes mellitus or with increased risk of diabetes (relatives of patients with diabetes), this study tests the hypothesis that an FFQ, adapted to local dietary habits, yields a reliable estimate of nutrient intake when compared with 7-day food record (7DR) in healthy, prediabetes, and diabetes cohorts. One hundred three volunteers (50 persons with overt diabetes mellitus, 24 relatives of patients with diabetes, and 29 nondiabetic individuals without a family history of diabetes) completed both FFQ and 7DR. A second FFQ was completed by 100 of these volunteers after 3 months to evaluate its reproducibility. Data were compared by correlation and Bland-Altman analyses. Across the entire group, estimates for gram intakes of nutrients and total energy were associated with wide limits of agreement between FFQ and 7DR (correlation coefficients, 0.23–0.72;  $P < .02$ ). Compared with 7DR, the FFQ overestimated intakes of saturated fat in the entire group ( $+6.6 \pm 14$  g;  $P < .001$ ) and in persons with overt diabetes mellitus ( $+7.6 \pm 15$  g;  $P < .001$ ) but underestimated protein intake in relatives of patients with diabetes ( $-16.36 \pm 31$  g;  $P = .01$ ). The repeated FFQ revealed variable agreement (correlation coefficients, 0.34–0.72;  $P < .001$ ) and underestimated ( $P < .01$ ) macronutrient and

**Abbreviations:** FFQ, food frequency questionnaire; 7DR, 7-day food record; CON, nondiabetic individuals without family history of diabetes; T2D, type 2 diabetes mellitus; T1D, type 1 diabetes mellitus; BLS II, German Nutrient Data Base; BMI, body mass index; WHR, waist-to-hip ratio; %EI, percentage of daily energy intake.

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total energy intakes, with slightly better performance in persons with overt diabetes mellitus and relatives of patients with diabetes than in nondiabetic individuals without a family history of diabetes. Hence, the FFQ allows measuring intakes of total energy and macronutrients in prediabetes and diabetes cohorts but reveals limitations when assessing dietary composition.

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## 1. Introduction

Lifestyle factors are tightly related to the pathogenesis of diabetes mellitus, and lifestyle modification is the basis of treating type 2 diabetes mellitus (T2D) and related disorders such as obesity, hypertension, and coronary artery disease [1]. Interventions based on dietary modification and increased physical activity also reduce the risk of T2D by 58% in glucose intolerant persons, who are at increased risk of T2D [2,3]. The habitual diet also affects the development of T2D [4–6]. Not only the total amount of energy intake but also the percentage share of fat and protein has been linked to insulin resistance, which generally precedes T2D [7]. Analysis of dietary behavior is therefore essential not only for evaluating the impact of food composition as risk factors but also for developing and monitoring effective prevention and intervention strategies in large human trials related to T2D [8].

Food frequency questionnaires (FFQs) capture the habitual dietary intake [9] and are widely used in large epidemiologic studies [10–12]. As FFQs are low cost and easy-to-use tools, they could be also applied to monitor nutritional habits during the course of clinical intervention trials. For this purpose, the ideal FFQ should accurately reflect the individual's food consumption over a defined period, independent of behavioral patterns or inaccurate memory [13]. Although FFQs have been validated against other methods such as weighed records or diet records in healthy humans [11], such validation is missing for assessing the complete dietary intake in individuals at risk of or with overt diabetes mellitus.

We hypothesized that an interviewer-administered FFQ provided a reliable estimate of nutrient intake in healthy, prediabetes, and diabetes cohorts. This FFQ has been previously used along with 24-hour recalls for dietary assessment in lifestyle intervention trials [14,15]. For the present study, we adapted this FFQ for local dietary habits and determined its variability by comparison with a 7-day food record (7DR) and the reproducibility by comparison with a second food frequency questionnaire (FFQ2) after a 3-month interval. The study design aimed to examine the hypothesis in outpatients attending services for prediabetes and/or diabetes in a defined metropolitan area of Vienna, Austria.

## 2. Methods and materials

### 2.1. Participants

The volunteers were consecutively recruited from the Diabetes Outpatient Service of the 1st Medical Department of Hanusch Hospital, Teaching Hospital of Medical University of Vienna, and from a local Physiotherapy Service, Vienna, Austria, between January 2008 and August 2008. Persons aged

19 years or more were included when they agreed to complete both FFQ and 7DR, to be available within the area throughout the study, able to understand and willing to participate, and sign the consent forms. Persons reporting relevant changes in nutritional habits within the last year, recently diagnosed and treated diabetes [16], and individuals with diseases affecting memory were excluded. All participants gave written informed consent after being explained the nature of the studies, which complied with the Declaration of Helsinki and were approved by the local ethics board.

For the variability study, the population consisted of 123 volunteers, including 27 nondiabetic relatives of patients with T2D who had at least one parent or grandparent with overt T2D, 66 patients with diabetes (32 patients with T2D and 34 with type 1 diabetes [T1D]), and 30 nondiabetic healthy individuals serving as control (CON). Participants with missing 7DR ( $n = 18$ ) or incomplete 7DR ( $n = 2$ ) were excluded from further evaluation. The attrition rates were 16% in the entire group, 3% in CON, 11% in relatives of patients with diabetes, and 24% in persons with overt diabetes mellitus.

For the reproducibility study, the population comprised 100 volunteers, including 23 relatives of patients with diabetes, 49 individuals with overt diabetes mellitus (26 T1D and 23 T2D), and 28 CON, after the exclusion of 23 cases due to missing FFQ2. The attrition rates were 19% in the entire group, 7% in CON, 15% in relatives of patients with diabetes, and 26% in individuals with overt diabetes mellitus. No participant of these studies attended the intervention trials, where this FFQ had been used [14,15].

### 2.2. Study design and methods

An FFQ containing 128 items [17] was modified into an interviewer-administered 107-item open-ended questionnaire adapted to local dietary habits. The FFQ measures the participant's usual food intake during a defined preceding period. For the 7DR, the participants recorded all food items and beverages according to a predefined protocol for 1 week. Each day, the participants had to fill in a structured one-page form and list all food items and beverages ingested at each meal and between meal times. The form did not provide food suggestions. Portion sizes were determined based on common household measuring units such as cups, bowls, spoons, and slices. Food frequency questionnaire and 7DR were analyzed using the German Nutrient Data Base (BLS II) [18]. One single-trained dietician performed both interviews. The calculation of nutrient and fluid intakes determined via FFQ was carried out as follows: every single item on the food listing was extrapolated by multiplying the portion sizes by the frequency of food consumption to obtain data in units per year and then entered into the BLS to yield mean values of energy intake (in kilojoules per day), carbohydrates, fat, protein, and saturated fat (grams per day and % of daily energy intake [%EI]), n-3 and n-6

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