JOURNAL OF INTERNATIONAL CRISIS AND RISK COMMUNICATION RESEARCH
ISSN: 2576-0017
2024, VOL 7, NO S6

Dietary intake and diabetes-related nutrition knowledge in people with type 2 diabetes

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Abstract

Background: Type 2 diabetes mellitus (T2DM) affects millions worldwide, leading to significant health and economic burdens. Effective dietary management, underpinned by nutrition-related knowledge, is essential for improving clinical outcomes in T2DM. However, limited research exists on the relationship between diabetes-specific nutrition knowledge and dietary intake patterns.

Methods: This study included 125 adults with T2DM who received standard dietary guidance. Nutrition knowledge was assessed using the dietary subscale of the Audit of Diabetes Knowledge (ADKnowl) questionnaire. Dietary intake was evaluated through detailed four-day food diaries, analyzed using validated software. The association between nutrition knowledge and nutrient intake was examined using multivariable regression, adjusting for potential confounders.

Results: The mean ADKnowl dietary subscale score was 59.2% (SD = 16.4). Higher nutrition knowledge was associated with greater energy intake relative to basal metabolic rate (EI:BMR ratio, 1.4 ± 0.5 vs. 1.1 ± 0.3, $P < 0.005$), higher fruit and vegetable consumption (322.8 ± 179.7 g vs. 230.8 ± 175.1 g, $P < 0.001$), and lower dietary glycemic index (58.4 ± 4.6 vs. 61.4 ± 4.5, $P < 0.002$). Those with lower knowledge demonstrated higher intake underreporting and consumed less sugar and non-milk sugar.

Conclusion: Diabetes-specific nutrition knowledge significantly influences dietary behaviors, particularly energy reporting, fruit and vegetable intake, and dietary glycemic index. Enhancing nutrition education in T2DM management may support improved dietary habits and metabolic health. Future research should explore targeted interventions to address gaps in dietary knowledge.

Introduction

Type 2 diabetes mellitus (T2DM) impacts millions of adults worldwide (1). It is linked to a higher risk of mortality, numerous co-existing health conditions, reduced quality of life, and a substantial economic strain. A critical component of managing T2DM involves dietary adjustments, which encourage adopting a nutritious diet to enhance metabolic health (2). Although many factors can affect an individual's ability to implement dietary guidelines, having a foundational understanding of nutrition is essential to achieve this goal (3). Consequently, a primary focus of self-management education for T2DM is to promote the development of nutrition-related knowledge and skills, enabling informed decision-making and effective self-care, which ultimately lead to improved clinical outcomes, better overall health, and enhanced quality of life (4).

Previous studies exploring the connection between knowledge and health outcomes in T2DM have predominantly centered on glycemic control but have often failed to identify a clear association (5,6). A significant drawback in prior research has been the reliance on cumulative knowledge scores, where multiple aspects of diabetes knowledge are aggregated, rather than evaluating specific knowledge areas in relation to directly relevant outcomes (5). In the general population, studies suggest a modest positive correlation between nutritional understanding and dietary habits, particularly higher fruit and vegetable consumption being linked to better knowledge (3,7). However, the association between nutrition knowledge and dietary practices among individuals with T2DM has received limited attention.

The objectives of the present research were twofold: (1) to assess diabetes-specific nutrition knowledge using a validated tool, along with the use of food labels and satisfaction with body weight among adults with T2DM

receiving routine care, and (2) to explore the relationship between nutrition knowledge related to diabetes and nutrient consumption patterns.

Materials and Methods

The study included 125 adults diagnosed with T2DM . Participants were aged 18 years or older, had been diagnosed with T2DM for at least six months, and were neither pregnant nor lactating. The research adhered to the ethical principles outlined in the Declaration of Helsinki and received approval from the Ethics and Medical Research Committee. Written informed consent was obtained from all participants before the study began. Upon enrollment, all participants received standard dietary guidance for T2DM management, emphasizing adherence to a balanced eating plan. This dietary advice focused on consuming a variety of portion-controlled foods such as fruits, vegetables, whole grains, low-fat dairy, and protein sources. It aimed to achieve a macronutrient distribution of 45–60% carbohydrates, less than 35% fats, and under 10% saturated fats. Foods high in sugar, fat, and salt were recommended only in moderation (8).

General knowledge about diabetes and nutrition-related knowledge was assessed using the self-administered Audit of Diabetes Knowledge (ADKnowl) questionnaire, which has been validated for use in T2DM populations as a cross-sectional tool (5). The questionnaire consists of 27 item sets (114 items) covering treatments, glycemic control, physical activity, risks of complications, foot care, and nutrition. This tool was designed to allow the removal of irrelevant items without compromising its validity. Scores were calculated as the percentage of correct answers for all applicable items, with possible scores ranging from 0% to 100%. Two specific subscales (item sets 11 and 12) assessed nutrition knowledge, comprising 16 questions relevant to all T2DM participants, regardless of treatment type. Higher scores indicated greater knowledge levels.

To complement knowledge assessment, participants were also asked about their use of food labels, including how often they consulted labels when selecting foods and checked the content of specific nutrients, using an approach similar to that of Fitzgerald et al. (9).

Dietary Assessment

Procedures for evaluating food intake among individuals with T2DM have been detailed in prior research (10). Participants were instructed not to change their typical eating habits and to record all food and beverages consumed over four consecutive days, including one weekend day. Detailed records were required regarding food types, brands, preparation methods, and cooking styles. A portable food-weighing scale (Tanita KD-400), household measures (e.g., cups, tablespoons), food packaging information, and a photographic food atlas were used to quantify portions.

Dietary data were analyzed using the Weighed Intake Software Programme (version 3; Tinuviel Software), which incorporates food composition data from the 5th and 6th editions of McCance and Widdowson's Food Composition Tables, along with supplemental volumes (11,12). The database was modified to include composite dishes, nutritional supplements, and commonly consumed local foods (13). When portion details were insufficient, average portion sizes (14,15) were used or estimated based on the researcher's observations of participants' eating patterns. Nutrient breakdowns for all recorded items were extracted for analysis. Basal metabolic rate (BMR) was estimated using the predictive equation of Henry (16). Energy intake (EI) was evaluated using the Goldberg et al. method (17), which calculates the EI:BMR ratio.

Anthropometry and Sociodemographic Data

Information on sociodemographic factors, medication use, and prior diabetes education was collected. Weight and height were measured to calculate BMI using the formula: weight (kg)/height² (m^2). Waist circumference was measured twice, at the midpoint between the lowest rib and the iliac crest, after normal expiration.

Biochemical Measurements

Blood samples were collected after an overnight fast to measure glycosylated hemoglobin (HbA1c) using an automated HPLC system (model HLC-723 G7; Tosoh).

Statistical Analysis

Data analysis was conducted using PASW Statistics version 20. Continuous variables were presented as means and standard deviations, with comparisons made using independent-sample t-tests for parametric data and Mann–Whitney U tests for non-parametric data. Dichotomous variables were compared using the chi-square test.

Multivariable linear regression analysis was performed to investigate the relationship between nutrition knowledge and nutrient intake, adjusting for potential confounders such as age, BMI, sex, EI:BMR ratio, food label use, and socioeconomic status. Linearity between variables was evaluated using box plots and normal P–P plots, while scatterplots of standardized residuals were used to check normality, linearity, and homoscedasticity. Outlier influence was assessed using Cook's distance, and multicollinearity was evaluated. Statistical significance was set at $P < 0.05$ for all analyses.

Results

A total of 120 participants (95%) completed the ADKnowl questionnaire. The average age of participants was 57.4 years (SD = 5.7), with a mean BMI of 32.5 kg/m^2 (SD = 5.9). The majority (64%) were male. Participants had been living with type 2 diabetes mellitus (T2DM) for an average of 7.7 years (SD = 4.8) and demonstrated

moderate glycemic control with a mean HbA1c of 61.2 mmol/mol (SD = 17.7). Most participants (69.4%) managed their condition with lifestyle modifications and oral hypoglycemic agents, while 19% also utilized insulin. A smaller group (11.6%) did not use medications to manage blood glucose levels.

Among the respondents, 120 individuals (95%) recalled the context in which they first received dietary education for diabetes: 53% participated in group sessions led by a dietitian and a diabetes nurse specialist, while 42% received one-on-one guidance. A substantial proportion (63%) reported that they had not received professional dietary advice for diabetes management in over a year. Sociodemographic attributes of this group were comparable to baseline characteristics from other T2DM populations reported in similar studies (18–21).

The overall mean score for correct answers on the ADKnowl assessment was 62.3% (SD = 15.1). High rates of correct responses (over 70%) were observed for topics such as general diabetes management, physical activity, complications, sick-day routines, insulin usage, injection practices, and foot care. Conversely, sections addressing dietary knowledge, alcohol, hypoglycemia, and blood glucose control scored 60% or less.

The average score for the dietary section of the ADKnowl assessment was 59.2% (SD = 16.4). Over 80% of participants recognized the relationship between salt intake and blood pressure as well as the high-fat content of fried foods, pastries, and cakes. While 92% understood that sugar increases blood glucose levels, only 66.9% correctly identified that starchy foods also elevate blood glucose.

Awareness regarding the effects of fruit and fruit juice on blood glucose was 62.9% and 59.3%, respectively. Fewer participants (44.4%) understood that certain margarines and spreads have energy content similar to butter, and only 29.8% knew that not all fats negatively affect cholesterol levels.

There was notable confusion regarding macronutrient effects on blood glucose. Only 36.3% and 16.1% knew that proteins and fats, respectively, do not directly affect blood glucose levels. Additionally, 66% believed that people with diabetes should avoid all foods containing sugar. The most poorly answered question addressed the insulin requirements for sugar and starch, with only 12.1% correctly responding that both require the same insulin dose based on carbohydrate content.

Participants were divided into two groups based on their ADKnowl dietary subscale scores. Those with lower dietary knowledge had a significantly lower energy intake to basal metabolic rate (EI:BMR) ratio (1.1 ± 0.3 vs. 1.4 ± 0.5, $P < 0.005$), indicating higher underreporting of dietary intake . Variables such as age, BMI, social class, T2DM treatment type, HbA1c levels, and duration of diabetes did not significantly differ between the groups .

Nutrient intake analysis revealed no significant differences in total carbohydrate, protein, fat, starch, or glycemic load percentages between the groups . However, participants with lower dietary knowledge reported significantly lower intake of sugar ($10.8\% \pm 4.7\%$ vs. $13.7\% \pm 4.6\%$, $P < 0.001$), non-milk sugar ($9.1\% \pm 4.8\%$ vs. $12.1\% \pm 4.7\%$, $P < 0.001$), and fruits/vegetables (230.8 ± 175.1 g vs. 322.8 ± 179.7 g, $P < 0.001$). The dietary glycemic index was significantly higher in this group (61.4 ± 4.5 vs. 58.4 ± 4.6, $P < 0.002$). These associations remained statistically significant after adjusting for potential confounders, including the EI:BMR ratio table 2

Table 1: Participant Characteristics

Characteristic	Value
Number of participants	120 (95%)
Age (years)	57.4 (SD = 5.7)
BMI (kg/m²)	32.5 (SD = 5.9)
Male participants	64%
Duration of T2DM (years)	7.7 (SD = 4.8)
HbA1c (mmol/mol)	61.2 (SD = 17.7)
Diabetes management method	
- Lifestyle + oral agents	69.4%
- Insulin	19%
- No medication	11.6%
Setting of initial dietary education	
- Group education	53%
- One-on-one education	42%
Time since last dietary advice	>12 months (63%)

Table 2: Diabetes Knowledge Audit

Subsection	Mean Correct Score (%)
Overall	62.3 (SD = 15.1)
General management	>70%
Complications	>70%
Physical activity	>70%
Sick-day management	>70%
Insulin	>70%
Injecting	>70%
Foot care	>70%
Diet and food	59.2 (SD = 16.4)
Alcohol	≤60%
Hypoglycemia	≤60%
Blood glucose control	≤60%

Discussion

This study explored the nutrition knowledge of individuals with type 2 diabetes (T2DM) receiving standard care, revealing that their understanding of dietary management was lower compared to other aspects of diabetes self-management. Despite shifting trends away from emphasizing patient knowledge (5), dietary changes remain a cornerstone of effective T2DM management. A strong grasp of dietary principles supports better decision-making and self-care. Interestingly, participants showed the highest understanding in areas related to diabetes complications but lacked practical knowledge for self-management, potentially leaving them less empowered to manage their condition effectively.

Participants generally grasped basic dietary concepts, such as the high-fat content of fried foods and the connection between salt intake and blood pressure. However, gaps were evident in more nuanced nutritional knowledge, especially regarding the effects of macronutrients on blood glucose. While most participants understood the impact of sugar, misconceptions persisted, such as believing all sugary foods must be avoided. Few recognized that starchy foods also raise blood glucose levels and require insulin. Additionally, confusion about fats and oils, their energy content, and their influence on cholesterol highlighted the need for clearer dietary guidance. An improved understanding of carbohydrate metabolism and the distinction between saturated and unsaturated fats is essential for glycemic control and cardiovascular risk management (22). These areas require greater emphasis in educational interventions for T2DM patients.

Previous research using the ADKnowl tool has consistently identified significant gaps in nutrition knowledge among individuals with T2DM under standard care. Studies in similar settings also reported knowledge deficits related to diet and nutrition (5, 23). While dietary education is typically provided at diagnosis, ongoing education is often inconsistent and infrequent, with dietary advice being reinforced only during periodic medical reviews focused on glycemic control through medication adjustments. In this study, most participants (63%) reported that they had not received dietary advice from a healthcare professional for over a year. To enhance outcomes, diabetes care should integrate continuous self-management education alongside medication adjustments throughout a patient's life. This may involve increasing dietitian availability and training other healthcare professionals to promote dietary self-management confidently (24). Experiential strategies like interactive cooking sessions or wearable devices to monitor behaviors could also improve patient engagement (25).

The link between nutrition knowledge and dietary habits has not been extensively studied in T2DM populations. Limited research, such as a study involving U.S. Latinas with T2DM, identified a positive relationship between nutritional knowledge and healthier food choices, though the effect was moderated by food label use (9). Using the ADKnowl tool and a 4-day food diary, this study found that participants with greater nutritional knowledge consumed more fruits and vegetables, had higher sugar intake (primarily non-milk sugars), and achieved a lower dietary glycemic index. These results suggest that individuals with higher knowledge adopt a more balanced diet rather than fixating solely on sugar restriction, a finding consistent with non-diabetic populations (3, 7). However, the cross-sectional nature of the study limits causal interpretations, warranting further research in larger samples.

Restrictive dietary practices, such as avoiding all sugary foods, can negatively impact quality of life for people with T2DM (26–28). Addressing this misconception through improved nutritional knowledge can help patients make informed choices that balance glycemic control with maintaining quality of life. A better understanding of nutrient contributions, including carbohydrates and fats, may encourage weight loss and support long-term weight management.

Participants expressed dissatisfaction with their weight, a concern reflected in the average BMI of 32.5 kg/m². While most participants aimed to manage their weight and reported using food labels, their focus on sugar

content rather than overall energy value was notable. Similar trends were observed in other studies (9). Providing education on how to interpret food labels holistically and emphasizing the role of all nutrients in energy balance could improve self-management skills for T2DM patients.

Additionally, the relatively small sample size and potential selection bias limit generalizability. However, the demographic characteristics of the participants were comparable to those reported in other studies (18–21).

In summary, this study identified significant gaps in nutritional knowledge among individuals with T2DM, particularly regarding macronutrients and their effects on blood glucose and lipid levels. These gaps were associated with poorer dietary choices, such as lower fruit and vegetable intake and higher dietary glycemic index. Improved education on the role of nutrients in glycemic control, cardiovascular risk, and weight management is essential to support effective self-management. Strategies for delivering continuous, integrated dietary education could enhance metabolic outcomes and improve the quality of life for individuals with T2DM.

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