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Article

Impact of Continuing Medical Education on Family Physicians' Knowledge and Clinical Decision-Making Regarding Intermittent Fasting in Type 2 Diabetes

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Abstract

Aims/Background: Intermittent fasting (IF) is increasingly adopted by patients with type 2 diabetes mellitus (T2DM), often without adequate medical supervision. Despite growing patient demand, family physicians frequently report limited formal training in fasting-related diabetes management. This study aimed to evaluate the efficacy of a structured continuing medical education (CME) intervention in improving family physicians' knowledge, confidence, and clinical decision-making regarding IF in T2DM. **Methods:** A single-group pre-test and post-test interventional design was employed. Four weekly CME sessions were delivered, with each participant attending one session comprising a didactic lecture. A structured questionnaire was administered before and after each session. A total of 180 participants who completed both assessments and provided informed consent were included in the final analysis. **Results:** The educational intervention produced a statistically significant increase in total knowledge scores (median [interquartile range, IQR]: 12.0 [10.0–15.25] vs. 18.0 [15.25–19.0], $Z = -9.17$, $p < 0.001$, $r = 0.68$). Significant improvements were also observed in exercise and diet ($r = 0.58$), diabetes management ($r = 0.43$), oral antidiabetic drug adjustment ($r = 0.64$), and insulin management ($r = 0.55$) (all $p < 0.001$). Self-perceived competence in managing patients with fasting T2DM increased from 33.3% to 75.6%, and confidence in medication dose and timing adjustment increased from 26.7% to 72.8%. Years in practice were not associated with knowledge gain (Spearman's $r_s = -0.058$, $p = 0.438$), and participant characteristics had only limited influence on educational outcomes. **Conclusion:** A structured guideline-based CME programme improved short-term knowledge and self-reported confidence regarding IF in T2DM.

Keywords: family physicians; continuing medical education; intermittent fasting; type 2 diabetes mellitus

1. Introduction

Intermittent fasting (IF) is a group of dietary patterns that alternate periods of eating with periods of voluntary abstinence from caloric intake. Common forms include time-restricted eating (e.g., 16 hours of fasting and 8 hours of eating), alternate-day fasting, and the 5:2 diet, in which individuals consume very low calories on two non-consecutive days per week. In recent years, IF has attracted considerable attention for its potential health benefits, including weight reduction, improvements in metabolic parameters, reductions in cardiovascular risk, and possible effects on longevity [1,2]. These benefits are thought to be mediated by mechanisms such as improved insulin sensitivity, reduced oxidative stress, modulation of circadian rhythms, and favourable changes in inflammatory pathways [3].

Extensive research has examined the effects of IF on glycaemic control and diabetes management. Fasting reduces insulin levels, promotes lipolysis, and shifts energy metabolism from glucose to fat and ketone utilisation [4]. In individuals with insulin resistance, these changes may improve glycaemic control by decreasing hepatic glucose production. Clinical trials and systematic reviews indicate that IF can reduce fasting blood glucose, glycated haemoglobin (HbA1c), and body weight in patients with type 2 diabetes, particularly when combined with overall caloric restriction [5,6]. However, outcomes are heterogeneous and depend on the specific fasting regimen and individual patient characteristics. While some studies report that IF is comparable to continuous calorie restriction for glycaemic control, others highlight the need for careful monitoring given variable patient responses to prolonged fasting [7,8].

The adoption of IF among individuals with type 2 diabetes is increasing. Population-based data indicate that fasting is highly prevalent among people with type 2 diabetes mellitus (T2DM): The multinational EPIDIAR study of 12,243 patients across 13 countries reported that approximately 79% of those with type 2 diabetes fasted for at least 15 days during Ramadan, frequently maintaining or self-adjusting their glucose-lowering treatment without medical supervision [9]. Beyond religious fasting, non-religious IF and time-restricted eating are increasingly adopted for weight loss and metabolic goals, often encouraged by non-medical sources rather than clinicians [10]. Non-medical sources, including social media and online health platforms, often promote fasting as a "natural" or "medication-free" approach to diabetes management. As a result, many patients initiate IF independently and may alter or discontinue their diabetes medications without professional guidance. This widespread, unsupervised practice underscores a significant gap between patient behaviours and the medical advice provided by healthcare professionals [11].

Despite its potential benefits, IF has disadvantages and potential complications in patients with type 2 diabetes. The primary concern is hypoglycaemia, especially in patients using insulin or insulin secretagogues like sulfonylureas [12]. Extended fasting periods may also increase the risk of dehydration, electrolyte imbalances, dizziness, and orthostatic hypotension, particularly in older adults or individuals with comorbidities [1]. Some patients may experience increased glycaemic variability, headaches, irritability, or decreased adherence to treatment plans. There are concerns about the long-term viability of IF and its psychological effects, including disordered eating patterns in vulnerable individuals [13]. Additionally, patients with advanced diabetes complications, chronic kidney disease, frailty, or those who are pregnant may not be suitable candidates for fasting interventions. Consequently, IF should not be regarded as a universally safe or appropriate approach for all patients with T2DM.

The role of family physicians is particularly critical in this context. The prevalence of type 2 diabetes continues to rise globally, placing a substantial burden on primary care systems [14]. Family physicians are often the first point of contact for patients seeking advice on lifestyle interventions, including diet and fasting practices. In daily practice, patients frequently ask questions such as whether they should take antidiabetic medications while fasting, how to use insulin on fasting days, or whether fasting is safe in the presence of comorbid conditions. Evidence from a primary care study indicates that patients trust family physicians for practical, individualised guidance on medication timing and risk prevention [15]. However, many physicians report limited formal training in IF, resulting in uncertainty and inconsistent counselling [12]. The literature increasingly emphasises the need for structured education for primary care clinicians on fasting-based dietary approaches, particularly regarding medication safety, patient selection, and monitoring strategies [16].

Continuing medical education (CME) consists of structured learning activities designed to enable physicians to maintain and enhance their knowledge, skills, and professional performance throughout their careers [17]. The primary objective of CME is to ensure that clinical practice remains aligned with current evidence and adapts to evolving patient needs. The present study aims to support family physicians in providing safe, evidence-based, and patient-centred guidance to individuals considering or practising IF. Additionally, the primary objective is to evaluate the efficacy of the educational intervention in improving T2DM management during IF.

2. Methods

2.1 Interventional Education

A single-group interventional educational design (pre-test and post-test) was utilised to improve family physicians' knowledge, attitudes, and intended clinical practices regarding IF in patients with type 2 diabetes mellitus (T2DM). The educational intervention was designed as a structured CME activity, focusing on: (i) Evidence supporting IF in T2DM, (ii) patient selection and contraindications, (iii) exercise and dietary recommendations, and (iv) principles for medication adjustment during fasting periods. A standardised intervention format ensured consistency across all participants. Outcomes were measured immediately before and after the educational activity using a pre-defined questionnaire.

2.2 Participants and Recruitment

The study was conducted in Kocaeli with 668 registered family physicians. Educational sessions were held weekly on Mondays, for a total of four sessions. Recruitment and data collection were carried out over four consecutive weekly sessions in November 2025, following ethics committee approval on 27 October 2025. Each physician attended one session as part of routine in-service training, and 500 family physicians attended one of these sessions.

All attending family physicians were invited to participate in the study voluntarily. Participation required completion of both the pre-test and post-test questionnaires and provision of informed consent for research use of their responses. Physicians who completed the tests but did not consent to participate in the study were excluded from the analysis.

2.3 The Educational Content

The CME content was developed by family medicine faculty with input from endocrinology and diabetes specialists and was aligned with current evidence and guideline-based diabetes care (Turkish Diabetes Association: Ramadan and Diabetes Guideline) [18]. The programme was organised into four modules:

(i) Evidence supporting IF in T2DM;

(ii) Patient selection and contraindications;

(iii) Exercise and dietary recommendations;

(iv) Principles for medication adjustment during fasting periods.

Teaching methods included a didactic lecture, clinical case discussions, concise decision algorithms, and a question-and-answer segment.

2.4 Questionnaire

Data were collected using a structured questionnaire specifically developed for this study. The questionnaire was developed based on a comprehensive literature review, and relevant items were adapted from previously published studies on fasting, diabetes education, and physician competence. To ensure scientific accuracy and content validity, endocrinology specialists reviewed the questionnaire and made necessary revisions. The questionnaire consisted of the following sections:

(1) Sociodemographic and professional characteristics.

(2) Personal exposure to diabetes and fasting.

(3) Attitudes and confidence in fasting-related diabetes management: Five Likert-scale questions assessed family physicians' perceived competence in managing patients with diabetes during Ramadan fasting and IF, including counselling, risk assessment, and medication adjustment [19]. This section was assessed separately.

(4) Exercise and dietary counselling during IF: Five knowledge-based statements regarding physical activity and nutrition for patients with diabetes practising IF were asked and assessed by true/false/I don't know items [11].

(5) Clinical scenarios on medication adjustment: Two case-based scenarios required participants to make decisions regarding dose adjustments of oral antidiabetic drugs and insulin for patients with T2DM who were practising IF. Fehime case was about a patient on oral antidiabetic drug treatment, and the Abdullah case was about a patient on an insulin regimen. All cases consisted of five multiple-choice questions about drug and insulin dosage regulations [12].

(6) Special population scenario: A final scenario assessed the appropriateness and safety of IF during pregnancy [11].

Content validity was established through expert review by family medicine faculty, and clarity was improved through pilot testing with 49 physicians not included in the main study. The intervention was conducted in Turkish; however, the English version of the questionnaire, including the case scenarios, was provided in the **Supplementary Material**. The five-item self-efficacy section demonstrated acceptable internal consistency (Cronbach's $\alpha = 0.746$).

2.5 Questionnaire Scoring

The knowledge assessment comprised 21 scored items (total score range 0–21), grouped into four domains—exercise and diet counselling (5 items, range 0–5), diabetes management during fasting (5 items, range 0–5), oral antidiabetic drug adjustment (Fehime case; 5 items, range 0–5), and insulin adjustment (Abdullah case; 5 items, range 0–5)—together with one special-population item on fasting during pregnancy. One point was awarded for each correct response and none for an incorrect or "I don't know" answer; multiple-choice case items had a single correct option with no partial credit. Self-efficacy percentages reported in the Results denote the proportion of participants selecting "confident" (Likert score 4 or 5), with scores of 1–3 grouped as "not confident".

2.6 Pre-Test and Post-Test

Participants completed the pre-test questionnaire immediately before the educational session and the post-test immediately after, using the same questionnaire to minimise recall bias. Each participant used the same quick response (QR) code to link their pre-test and post-test responses. Only responses from participants who completed both pre-test and post-test assessments and provided informed consent were included in the final analysis. After excluding responses due to unmatched codes, incomplete data, or lack of consent, 180 participants were included in the final analysis (Fig. 1).

2.7 Statistical Analysis

Continuous variables were assessed for normality using the Shapiro–Wilk test. As total and subdomain scores were not normally distributed, continuous data were summarised as median (interquartile range, IQR) and analysed using non-parametric tests. Pre-test and post-test continuous scores were compared using the Wilcoxon signed-rank test, and paired categorical item responses were analysed using McNemar's test. Associations between years in medical practice and continuous knowledge scores (pre-test, post-test, and change scores) were assessed using Spearman's rank correlation coefficient because the score distributions were non-normal. Correlation coefficients (r_s) and corresponding p-values were reported. For the Wilcoxon signed-rank comparisons, the effect size was calculated as $r = |Z| / \sqrt{N}$, where N is the number of paired observations, and interpreted using Cohen's thresholds as small ($r \approx 0.10$), medium ($r \approx 0.30$), and large ($r \approx 0.50$). Because the Spearman correlations were computed on pairwise-complete observations, the two participants who completed only the pre-test were excluded, so the pre-test total, post-test total and years in practice were available for all 180 participants, giving $n = 180$ for every panel of Fig. 2.

3. Results

3.1 Demographic and Professional Characteristics of Participants

The study sample consisted of 180 physicians. Of the participants, 54.4% were women ($n = 98$) and 45.6% were men ($n = 82$); years in medical practice ranged from 1 to 38 years, with a median of 9.5 years.

Regarding participants' personal and family history of type 2 diabetes mellitus (T2DM), the majority (92.8%, $n = 167$) reported not having a personal diagnosis of T2DM, while 6.1% ($n = 11$) were diagnosed with the condition. A small proportion (1.1%, $n = 2$) declined to answer. In contrast, a substantial proportion of participants reported having a family member diagnosed with T2DM: 30.2% ($n = 54$) indicated a positive family history, while 68.9% ($n = 124$) reported no such history in their household.

Participants were also asked about their personal fasting habits, which is relevant to their cultural competence

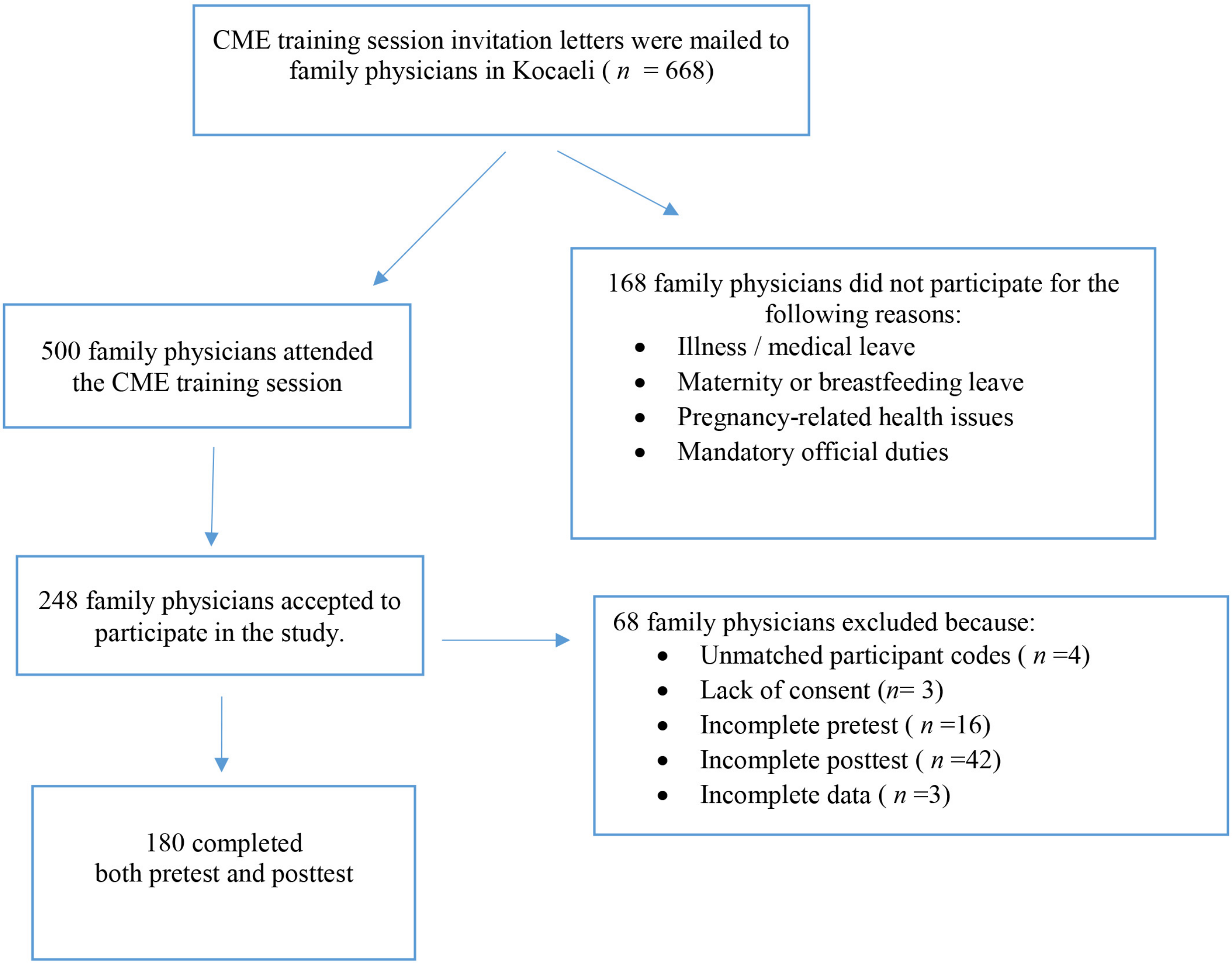

Fig. 1. Study flow diagram. CME, continuing medical education.

and personal experience with the physiological effects of fasting. A substantial majority, 67.2% (n = 121), reported fasting only during Ramadan (Table 1).

3.2 Changes in Total and Domain Scores from Pre-Test to Post-Test

Normality assessment using the Shapiro–Wilk test indicated that total and subdomain scores were not normally distributed; therefore, continuous paired comparisons were analysed using the Wilcoxon signed-rank test and are presented as medians (IQRs). The median total score increased from 12.0 (IQR 10.0–15.25) before the training to 18.0 (IQR 15.25–19.0) after the training (Z = –9.17, p < 0.001). Similar statistically significant improvements were identified in the Exercise/Diet, diabetes management, Fehime case, and Abdullah case domains (all p < 0.001), indicating that the intervention was effective across both theoretical knowledge and case-based clinical decision-making. Changes in total and subdomain scores from pre-test to post-test are presented in Table 2. The magnitude of improvement across all knowledge domains is summarised in Fig. 3.

Table 1. Demographic characteristics of participants.

Characteristics	*n*	%
Gender		
Female	98	54.4
Male	82	45.6
Personal history of T2DM		
Yes	11	6.1
No	167	92.8
Declined to answer	2	1.1
Family history of T2DM		
Yes	54	30.0
No	124	68.9
Declined to answer	2	1.1
Fasting habit (esp in Ramadan)		
Yes	121	67.2
No	49	27.2
Declined to answer	10	5.6

N = 180. Data are presented as frequencies (percentages). T2DM, type 2 diabetes mellitus.

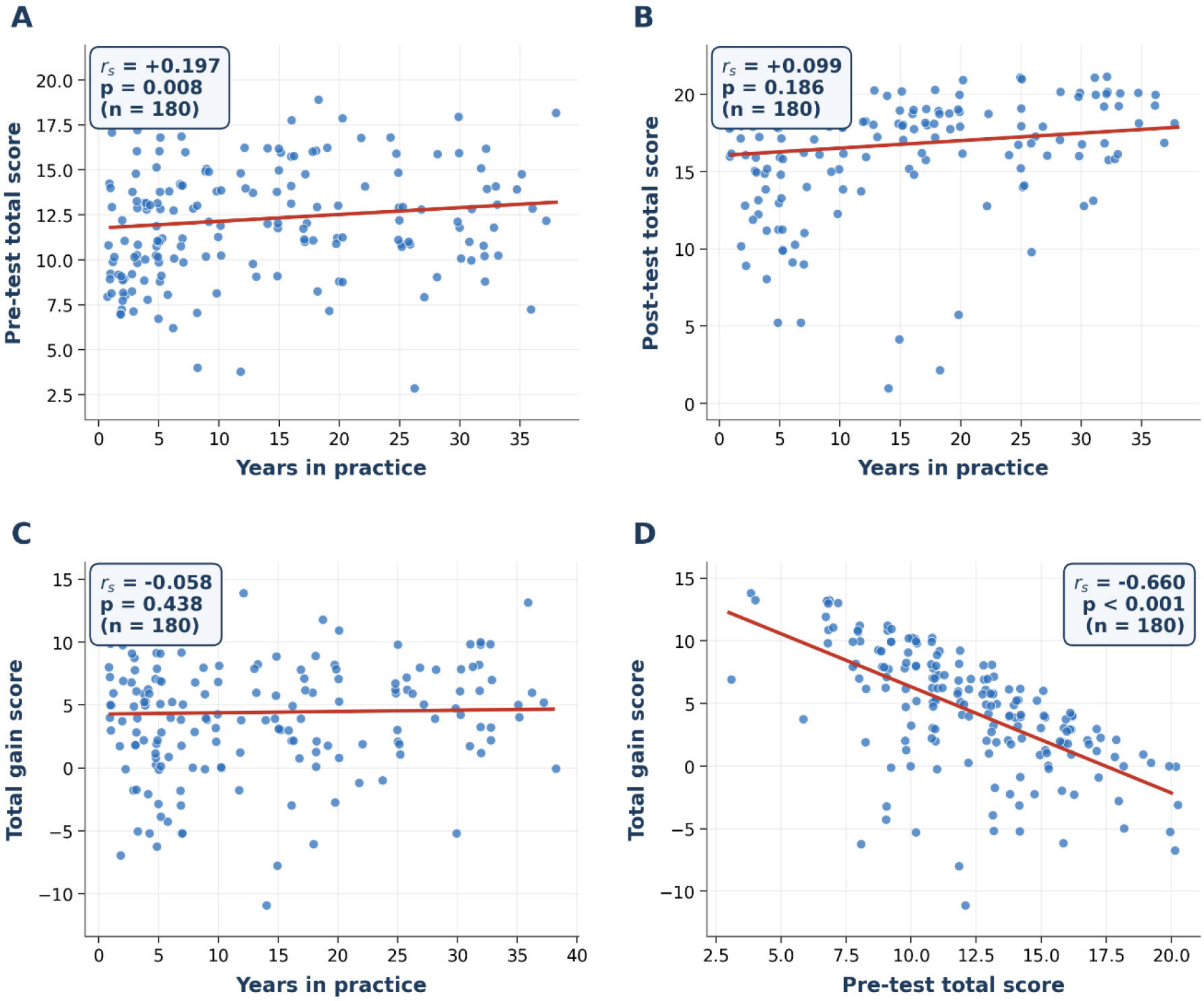

Fig. 2. Spearman correlations between experience and knowledge scores. (A) shows scatter plots of years in medical practice versus pre-test total knowledge score. (B) displays years in practice versus total gain score. (C) presents pre-test total score versus total gain score. Spearman's rank correlation coefficient (r_s) and its p-value are displayed within each panel.

Table 2. Changes in total and subdomain scores from pre-test to post-test.

Domain/score	n	Pre-test median (IQR)	Post-test median (IQR)	Z	p	r
Total score	180	12.0 (10.0–15.25)	18.0 (15.25–19.0)	–9.17	<0.001	0.68
Exercise/Diet	180	4.0 (3.0–5.0)	5.0 (5.0–5.0)	–7.76	<0.001	0.58
Diabetes management	180	3.0 (2.0–4.0)	4.0 (3.0–5.0)	–5.80	<0.001	0.43
Oral antidiabetics (Fehime case)	180	2.0 (1.0–4.0)	4.0 (4.0–5.0)	–8.64	<0.001	0.64
Insulin treatment (Abdullah case)	180	2.0 (1.0–3.0)	4.0 (3.0–4.0)	–7.43	<0.001	0.55

Data are presented as medians (interquartile ranges, IQRs). Pre-test to post-test comparisons were performed using the Wilcoxon signed-rank test.

3.3 Item-Level Paired Categorical Changes

Paired categorical responses were analysed using McNemar's test (Table 3). Statistically significant improvements were observed in both self-perceived competence and the majority of case-based clinical items. Self-perceived competence in managing patients with fasting T2DM rose from 33.3% to 75.6% (χ^2 = 54.09, p < 0.001), and confidence in adjusting medication dose and timing increased from 26.7% to 72.8% (χ^2 = 64.04, p < 0.001). Significant gains were also evident across the Fehime (oral antidiabetic) case items (Q22–Q26) and the Abdullah (insulin) case items addressing treatment adjustment (Q28–Q31). By contrast, correct recognition that the high-risk Abdullah profile should not fast was already high at baseline and did not change (Q27B: 94.4% vs. 93.3%, χ^2 = 0.06, p = 0.804), while the pregnancy scenario showed a modest

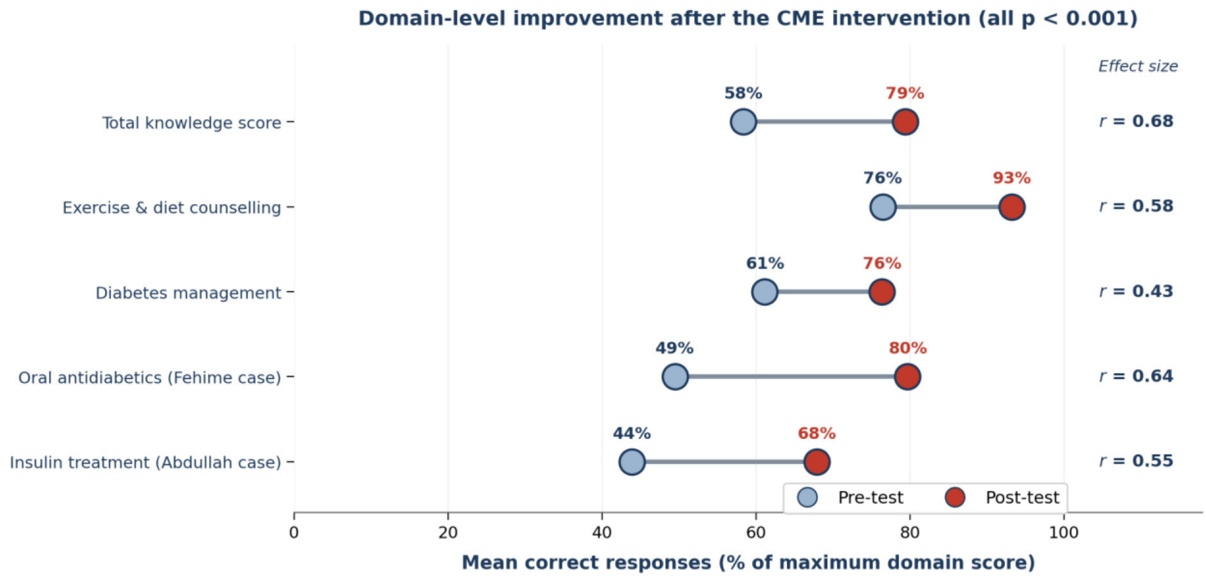

Fig. 3. Domain-level improvement in mean correct-response rates from pre-test to post-test, expressed as a percentage of the maximum score in each knowledge domain (blue = pre-test, red = post-test). The Wilcoxon signed-rank effect size (r) is shown at the right of each domain. All within-domain improvements were statistically significant ($p < 0.001$).

improvement (Q32: 71.1% vs. 81.1%, $\chi^2 = 4.52$, $p = 0.033$), as detailed in Table 3.

3.4 Associations With Years in Practice

Spearman correlation analysis was used to assess associations between years in medical practice and knowledge scores. Years in practice showed a weak positive correlation with the pre-test total score ($r_s = 0.197$, $p = 0.008$), but not with the post-test total score ($r_s = 0.099$, $p = 0.186$) or the total change score ($r_s = –0.058$, $p = 0.438$). A strong negative correlation was found between the pre-test total score and the total gain score ($r_s = –0.660$, $p < 0.001$) (Fig. 2).

3.5 Factors Influencing Knowledge Scores and Learning Gains

Because score distributions were non-normal, between-group comparisons were performed using the Mann–Whitney U test and are reported as medians with interquartile ranges, together with the Z statistic and p-value (Table 4a and Table 4b). There were no significant sex-based differences in total pre-test ($Z = -0.88$, $p = 0.377$), post-test ($Z = -0.57$, $p = 0.566$), or gain scores ($Z = -1.35$, $p = 0.178$); however, male physicians showed a marginally larger Exercise/Diet gain than female physicians ($Z = -2.20$, $p = 0.028$) (Table 4a and Table 4b).

Participants with and without a personal diagnosis of T2DM did not differ significantly in total pre-test, post-test, or gain scores ($p = 0.981$, $p = 0.594$, and $p = 0.480$, respectively), nor in any subdomain gain score; these comparisons should be interpreted cautiously given the small subgroup with personal T2DM ($n = 11$) (Table 4b).

Participants with a family history of T2DM did not differ from those without at baseline ($Z = -0.74$, $p = 0.462$) but achieved significantly lower post-test total scores ($Z = –1.99$, $p = 0.046$) and gain scores ($Z = –2.26$, $p = 0.024$); those without a family history reached a higher post-test median (18.0 vs. 16.5) and a larger median gain (5.0 vs. 3.0). A parallel difference was observed in the Exercise/Diet gain score ($Z = –2.32$, $p = 0.020$) (Table 4b).

Ramadan fasting habit was unrelated to total pre-test, post-test, or gain scores ($p = 0.221$, $p = 0.766$, and $p = 0.486$, respectively); nonetheless, physicians who fasted during Ramadan had higher baseline Exercise/Diet scores ($Z = -2.56$, $p = 0.010$) and a different Exercise/Diet gain ($Z = –2.38$, $p = 0.017$) than those who did not fast (Table 4b).

Overall, participant characteristics exerted only a limited influence on educational outcomes: Within-group Wilcoxon analyses confirmed significant pre-to-post improvement on the total score and all major domains in every subgroup, irrespective of gender, personal T2DM status, family history, or Ramadan fasting habit.

4. Discussion

This study demonstrates that a structured continuing medical education (CME) programme improved questionnaire-based clinical decision-making performance regarding IF in patients with type 2 diabetes mellitus (T2DM). The magnitude of change across total scores, subdomains, and case-based scenarios indicates that targeted education can rapidly reduce knowledge gaps in an area where patient demand is increasing but formal training remains limited.

Table 3. Changes in selected item-level correct responses from pre-test to post-test.

Item (correct response)	n	Pre-test, n (%)	Post-test, n (%)	χ^2	p
Self-efficacy: Competent to manage fasting T2DM patients	180	60 (33.3)	136 (75.6)	54.09	<0.001
Self-efficacy: Confident adjusting medication dose/timing	180	48 (26.7)	131 (72.8)	64.04	<0.001
Self-efficacy: Understands patient's wish to fast & needs	180	129 (71.7)	152 (84.4)	8.80	0.003
Self-efficacy: Has knowledge to manage fasting T2DM	180	95 (52.8)	149 (82.8)	31.92	<0.001
Self-efficacy: Adequately trained for fasting T2DM care	180	61 (33.9)	148 (82.2)	73.23	<0.001
Q22. Fehime case—general fasting recommendation	180	86 (47.8)	134 (74.4)	25.69	<0.001
Q23. Fehime case—metformin twice daily	180	141 (78.3)	171 (95.0)	21.02	<0.001
Q24. Fehime case—sulfonylurea twice daily	180	80 (44.4)	134 (74.4)	32.66	<0.001
Q25. Fehime case—DPP-4 inhibitor plus sulfonylurea	180	70 (38.9)	139 (77.2)	46.71	<0.001
Q26. Fehime case—SGLT-2 inhibitor only	180	68 (37.8)	139 (77.2)	48.51	<0.001
Q27B. Abdullah case—high-risk profile should not fast	180	170 (94.4)	168 (93.3)	0.06	0.804
Q28. Abdullah case—insulin plus oral antidiabetic regimen	180	60 (33.3)	121 (67.2)	37.89	<0.001
Q29. Abdullah case—once-daily basal insulin	180	54 (30.0)	97 (53.9)	22.91	<0.001
Q30. Abdullah case—twice-daily rapid-acting insulin	180	53 (29.4)	124 (68.9)	44.14	<0.001
Q31. Abdullah case—premixed insulin regimen	180	58 (32.2)	101 (56.1)	17.47	<0.001
Q32. Pregnancy scenario—fasting not recommended	180	128 (71.1)	146 (81.1)	4.52	0.033

T2DM, type 2 diabetes mellitus; SGLT-2, sodium-glucose cotransporter-2; DPP-4, dipeptidyl peptidase-4.

Table 4a. Comparison of total pre-test and post-tests according to participant characteristics.

Characteristic	Outcome	Group	Median (IQR)	Group	Median (IQR)	Z	p
Gender	Pre-test total	Male (n = 82)	12.0 (9.25–14.0)	Female (n = 98)	12.0 (10.0–15.0)	−0.88	0.377
Gender	Post-test total	Male	18.0 (16.0–19.0)	Female	18.0 (15.0–19.0)	−0.57	0.566
Gender	Gain score	Male	5.0 (3.0–8.0)	Female	4.5 (1.0–7.0)	−1.35	0.178
Personal T2DM diagnosis	Pre-test total	Yes (n = 11)	13.0 (9.5–15.0)	No (n = 167)	12.0 (10.0–14.5)	−0.02	0.981
Personal T2DM diagnosis	Post-test total	Yes	18.0 (16.5–19.5)	No	18.0 (15.5–19.0)	−0.53	0.594
Personal T2DM diagnosis	Gain score	Yes	6.0 (3.5–7.5)	No	5.0 (1.5–8.0)	−0.71	0.480
Family history of T2DM	Pre-test total	No (n = 124)	12.0 (10.0–14.0)	Yes (n = 54)	13.0 (10.25–15.0)	−0.74	0.462
Family history of T2DM	Post-test total	No	18.0 (16.0–19.0)	Yes	16.5 (13.75–19.0)	−1.99	**0.046**
Family history of T2DM	Gain score	No	5.0 (2.0–8.0)	Yes	3.0 (0–6.25)	−2.26	**0.024**
Fasting habit (Ramadan)	Pre-test total	No (n = 49)	12.0 (10.0–14.0)	Yes (n = 121)	13.0 (10.0–15.0)	−1.22	0.221
Fasting habit (Ramadan)	Post-test total	No	18.0 (16.0–19.0)	Yes	18.0 (16.0–19.0)	−0.30	0.766
Fasting habit (Ramadan)	Gain score	No	5.0 (2.0–8.0)	Yes	4.0 (2.0–8.0)	−0.70	0.486

IQR, interquartile range (Q1–Q3). Between-group comparisons were performed using the Mann–Whitney U test. Bold values indicate statistically significant differences ($p < 0.05$). T2DM, type 2 diabetes mellitus. Results for the personal T2DM diagnosis subgroup should be interpreted with caution given the small subgroup size (n = 11).

Table 4b. Comparison of Exercise/Diet and other subdomain scores according to participant characteristics.

Characteristic	Outcome	Group	Median (IQR)	Group	Median (IQR)	Z	p
Gender	Exercise/Diet gain	Male (n = 82)	1.0 (0–2.0)	Female (n = 98)	1.0 (0–1.0)	−2.20	**0.028**
Personal T2DM diagnosis	Exercise/Diet gain	Yes (n = 11)	1.0 (1.0–2.0)	No (n = 167)	1.0 (0–2.0)	−1.61	0.109
Personal T2DM diagnosis	Diabetes management gain	Yes	0 (0–2.0)	No	1.0 (0–2.0)	−0.27	0.791
Personal T2DM diagnosis	Fehime case gain	Yes	1.0 (0.5–2.0)	No	2.0 (0–3.0)	−0.45	0.652
Personal T2DM diagnosis	Abdullah case gain	Yes	2.0 (1.5–3.0)	No	1.0 (0–2.0)	−1.46	0.144
Family history of T2DM	Exercise/Diet gain	No (n = 124)	1.0 (0–2.0)	Yes (n = 54)	0.5 (0–1.0)	−2.32	**0.020**
Fasting habit (Ramadan)	Exercise/Diet pre-test	No (n = 49)	4.0 (3.0–4.0)	Yes (n = 121)	4.0 (3.0–5.0)	−2.56	**0.010**
Fasting habit (Ramadan)	Exercise/Diet gain	No	1.0 (1.0–2.0)	Yes	1.0 (0–1.0)	−2.38	**0.017**

IQR, interquartile range (Q1–Q3). Between-group comparisons were performed using the Mann–Whitney U test. Bold values indicate statistically significant differences ($p < 0.05$). T2DM, type 2 diabetes mellitus. Results for the personal T2DM diagnosis subgroup should be interpreted with caution given the small subgroup size (n = 11).

Beyond statistical significance, the magnitude of the observed knowledge gain suggests a meaningful educational impact, indicating that the intervention led to improvements in physicians' competence in managing T2DM during IF. Such gains are particularly relevant for brief CME interventions.

Significant improvements were observed across all knowledge domains, with particularly marked improvements in case-based medication adjustment questions.

This pattern suggests that case-based, scenario-driven teaching may be effective in strengthening clinical decision-making skills. In contrast, the more moderate effect in the general diabetes management domain may reflect greater baseline familiarity with theoretical concepts.

Overall, these results demonstrate that the intervention produced both statistically significant and practically meaningful educational gains, reinforcing the value of structured, guideline-based training in primary care settings.

At baseline, misconceptions were particularly evident in medication management and safety thresholds. This finding is consistent with previous literature showing that clinicians often report uncertainty when advising patients on fasting-related diabetes care, especially regarding insulin adjustment, sulfonylureas, and newer agents such as sodium-glucose cotransporter-2 (SGLT-2) inhibitors [16]. Although international guidelines increasingly recognise lifestyle modification, specific structured algorithms for IF are not uniformly integrated into routine primary care education [19]. As a result, practice patterns may vary widely.

The high rate of incorrect responses related to insulin injections and fasting likely reflects the interaction between biomedical knowledge and culturally embedded beliefs. In fasting contexts such as Ramadan, physicians must navigate religious considerations while ensuring safety. Without evidence-based training, counselling may rely on personal interpretation rather than guideline-informed risk stratification. Consistent with the findings of Beshyah et al. (2017) [20] and Zainudin et al. (2018) [21], who reported gaps in primary care physicians' confidence and preparedness in managing patients fasting during Ramadan, our results demonstrate that a structured educational intervention led to a substantial and statistically significant improvement in both theoretical knowledge and case-based clinical decision-making in T2DM management during fasting.

The significant increase in total knowledge aligns with evidence that structured CME interventions—particularly those combining didactic teaching with case-based reasoning—are associated with measurable improvements in clinician performance [17,22]. Furthermore, participants with lower baseline knowledge demonstrated greater post-intervention gains, likely reflecting greater room for improvement. Importantly, improvements were not limited to theoretical items but also extended to complex clinical scenarios involving medication adjustment. In line with Ahmedani et al. (2016) [12], who highlighted gaps in general practitioners' Ramadan-specific knowledge and clinical practices in diabetes care, our findings similarly demonstrate baseline deficiencies in competence; however, unlike their cross-sectional assessment, our study shows that a structured educational intervention can significantly improve physicians' knowledge, confidence, and case-based management skills during Ramadan fasting.

The largest gains were observed in the management of sulfonylureas, insulin regimens, and SGLT-2 inhibitors. This is clinically relevant. Systematic reviews indicate that while IF may modestly reduce HbA1c and body weight, safety concerns—especially hypoglycaemia and dehydration—remain central in medicated patients [7,23]. Furthermore, improvement in medication adjustment for SGLT-2 inhibitors is particularly important. Recent observational data highlight an association between SGLT-2 inhibitor use and increased risk of euglycaemic ketoacidosis under conditions of reduced caloric intake or dehydration [24]. Strengthening physicians' understanding of when to withhold or modify therapy during fasting, therefore, has direct patient safety implications.

4.1 Experience and Learning Dynamics

A weak positive correlation between years of practice and baseline knowledge suggests experiential accumulation of informal knowledge. However, the absence of association between professional seniority and post-test performance indicates that the educational intervention equalised competence across experience levels. This supports the concept that CME can standardise care delivery and reduce practice variability [22].

Physicians who fasted during Ramadan demonstrated higher baseline knowledge in exercise and dietary recommendations. Personal fasting experience may increase intuitive understanding of meal timing and energy management. However, experiential familiarity did not confer an advantage in medication safety domains. This finding highlights a critical distinction between experiential knowledge and pharmacological competence.

Similarly, physicians with a family history of T2DM showed smaller relative gains. One interpretation is that prior informal exposure may anchor certain assumptions, moderating the magnitude of cognitive restructuring during CME. Educational theory suggests that pre-existing beliefs can influence receptivity to new information, especially in areas intersecting lifestyle and cultural practice [25]. Structured, evidence-based content is therefore essential to recalibrate informal knowledge toward guideline-aligned reasoning.

The rising global burden of T2DM places increasing responsibility on primary care [26]. Concurrently, IF is increasingly adopted by patients, often without professional supervision [27]. Meta-analyses indicate that IF may achieve glycaemic improvements comparable to continuous calorie restriction in selected populations [13,23].

However, heterogeneity in outcomes and the risk of potential adverse events underscore the need for clinician-guided implementation.

This study demonstrates that a structured CME intervention can substantially enhance physicians' preparedness to provide evidence-based guidance. Notably, improvements were observed in both confidence and objective knowledge. Although self-perceived competence does not ensure behavioural change, confidence is a recognised mediator of clinical decision-making and the quality of patient counselling [22].

The persistence of some residual misconceptions—particularly around insulin and fasting status—suggests that culturally sensitive topics may require repeated reinforcement or supplementary materials. Future CME programmes may benefit from integrating algorithm cards, digital decision tools, or follow-up workshops to consolidate learning.

4.2 Limitations and Future Directions

The single-group pre-test and post-test design limits causal inference and does not control for testing effects. The immediate post-intervention assessment does not capture long-term knowledge retention or translation into clinical behaviour. Additionally, outcomes were physician-centred rather than patient-centred.

Future research should assess whether CME-driven improvements translate into measurable clinical outcomes, such as reduced hypoglycaemia incidence during fasting periods, improved glycaemic stability, or fewer emergency visits. Randomised or cluster-controlled designs would strengthen evidence regarding effectiveness.

5. Conclusion

A structured CME intervention significantly improved family physicians' knowledge, clinical reasoning, and confidence in managing patients with type 2 diabetes during IF. The programme effectively addressed safety-related misconceptions and strengthened medication adjustment competence across experience levels.

With the increasing prevalence of IF among individuals with diabetes, primary care physicians require structured, evidence-based education to deliver safe and individualised counselling. Continuing medical education is essential for aligning clinical practice with evolving dietary trends and for strengthening physicians' preparedness to counsel patients safely. Because the present study evaluated physicians' knowledge, confidence, and case-based decision-making immediately after the intervention, its findings should not be extrapolated to patient-level outcomes such as glycaemic control or hypoglycaemia; establishing that link will require studies that measure clinical endpoints and prescribing behaviour.

Key Points

- At baseline, family physicians' self-efficacy was limited, with only 33.3% considering themselves competent to manage type 2 diabetes during IF and 26.7% confident in adjusting medication dose and timing.
- A structured CME intervention significantly increased the median total knowledge score from 12.0 (IQR 10.0–15.25) at pre-test to 18.0 (IQR 15.25–19.0) at post-test ($Z = -9.17$, $p < 0.001$, $r = 0.68$).
- Knowledge gains extended beyond factual items to the case-based medication-adjustment scenarios, although the single-group design cannot isolate the specific contribution of any individual teaching component.
- The intervention's benefit was independent of professional experience, as years in practice correlated weakly with pre-test scores ($r_s = 0.197$, $p = 0.008$) but not with knowledge gain ($r_s = -0.058$, $p = 0.438$).
- Clinically important knowledge gaps persisted after training, with correct-response rates for the insulin-plus-oral-agent regimen (Q28: 67.2%) and the premixed insulin regimen (Q31: 56.1%) remaining limited, underscoring the need for reinforcement and decision support in high-risk patients.

Availability of Data and Materials

The datasets analysed during the current study are available from the corresponding author on reasonable request. Due to ethical and privacy considerations, individual-level data are not publicly accessible.

Author Contributions

Conceptualization: CT; Methodology: CT and TMA; Data Collection: CT; Formal Analysis: TMA; Writing—Original Draft Preparation: CT. Both authors contributed to revising the manuscript critically for important intellectual content. Both authors have read and approved the final manuscript. Both authors have participated sufficiently in the work and agreed to be accountable for all aspects of the work.

Ethics Approval and Consent to Participate

Ethical approval was obtained from the Medical School, Umuttepe Campus, Kocaeli University Ethics Committee of Non-clinical Research before participant recruitment on 27 October 2025 under approval number: 2025/477. Participation was voluntary, and all participants gave informed consent. Data were collected anonymously or pseudonymously (coded), stored securely, and used exclusively for research purposes. No personally identifiable information was included in the analysis or reporting. Participants were informed they could withdraw at any time without any consequences. The educational intervention posed minimal risks and was aligned with routine CME activities. The study was conducted in accordance with the principles of Good Clinical Practice and the Declaration of Helsinki.

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Conflicts of Interest

The authors declare no conflicts of interest.

Supplementary Material

Supplementary material associated with this article can be found, in the online version, at https://doi.org/10.31083/BJHM51130.

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