



Research article

Uptake and effectiveness of online diabetes continuing education: The perspectives of Thai general practitioner trainees

Isaraporn Thepwoonga^{a,*}, Radhakrishnan Muthukumar^b, Poompong Sripa^c, Leon Piterman^d^a Family Medicine Unit, Department of Community Medicine, Faculty of Medicine, Khon Kaen University, Thailand^b Academic Affairs, Faculty of Medicine, Khon Kaen University, Thailand^c Medicine for the Elderly Department, Royal Infirmary of Edinburgh, Edinburgh, United Kingdom^d Department of General Practice, School of Public Health and Preventive Medicine, Monash University, Australia

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ABSTRACT

Background: Despite continuing medical education (CME) programmes on evidence-based diabetes care, evidence-based best practice and actual GP practice remain scant. Online CME offers numerous benefits to general practitioners (GPs), particularly during the coronavirus disease 2019 (COVID-19) pandemic. In Thailand, CME is a voluntary process and is yet to be established as a mandatory requirement. This study examined GP uptake of online diabetes CME and the changes in GPs' attitudes to and knowledge of Type 2 diabetes management.

Methods: A cross-sectional study and a before-and-after study were employed with 279 GP trainees who voluntarily undertook a newly-developed online diabetes programme. A follow-up survey was conducted six months after the GP trainees completed their training.

Results: One hundred and twelve out of 279 GP trainees (40.1%) participated in the study, of whom 37 (13.3%) enrolled in the online diabetes programme, and 20 (7.2%) completed the programme. Before enrolling in the programme, the participants' mean diabetes knowledge score was 61.5%. The participants' confidence in effective insulin treatment increased significantly after the programme (95% Confidence interval [CI], -0.51 - 0.00 ; $P = 0.05$), but their knowledge scores before and after the programme were not statistically different (95% CI, -3.93 - 0.59 ; $P = 0.14$).

Conclusion: Uptake of the online diabetes CME was poor, although appropriate recruitment strategies were employed, and the online educational option was attractive and accessible during the COVID-19 pandemic. This study emphasises the gap between evidence-based practice and actual GP practice and the need for mandatory CME.

1. Introduction

General practitioners (GPs) play an essential role in diabetes management, providing initial, coordinating, continuing, and comprehensive care. To improve diabetes care by GPs, some evidence suggests that GP type 2 diabetes (T2D) education programmes

* Corresponding author. Family Medicine Unit, Department of Community Medicine, Faculty of Medicine, Khon Kaen University, Khon Kaen province, 40002, Thailand.

E-mail address: tisara@kku.ac.th (I. Thepwoonga).

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improve GP satisfaction, knowledge, practice, and patient outcomes [1]. However, evidence supporting their effectiveness is partial and weak due to the small number of studies examining their effectiveness [1].

Continuing medical education (CME) is a common strategy to maintain the quality of GPs' clinical practice [2]. Systematic reviews have suggested that CME educational methods which are effective in producing positive changes in physician practices and clinical outcomes are combined multiple educational interventions [3–7]. Small-group discussions, interactive workshops, educational outreach visits, audits and feedback and reminders change healthcare providers' behaviour [3,6,8,9], whilst formal CME formats such as lectures, workshops, educational meetings and distribution of educational materials do not produce positive changes in healthcare providers' behaviours [3–5,10]. Because of its numerous benefits, including convenience and flexibility for GPs, online CME has been expanded recently [11–13], particularly during the coronavirus disease (COVID-19) pandemic [14]. Although a previous systematic review suggested that online CME improved GP satisfaction, knowledge, and practice, few well-designed studies have focused on this mode of educational delivery [13]. Furthermore, the poor uptake of online CME by GPs is evident [15,16].

In Thailand, CME is voluntary, and mandatory CME is yet to be established. The Centre for Continuing Medical Education (CCME) was established to provide continuing education of medical practitioners in the year 2000 to encourage medical practitioners to continually improve their knowledge of, competence and skills in, and attitudes to their profession [17]. Although CME is not yet mandatory, physicians in Thailand can obtain or claim CME credits following the regulations of the CCME, and members of the Thai Medical Council can check and update their CME credits through the CCME website [18]. The Royal College of Family Physicians of Thailand (RCFPPT) emphasises the importance of CME, and is in the process of implementing the registration of members within the next few years, following the regulations on continuing education of the Thai Medical Council. CME learning needs assessment for a group of Thai community GPs and nurses showed T2D management was one of the most-needed topics, and structured online learning was the most preferred delivery method [19].

Despite the availability of continuing professional development programmes on evidence-based diabetes care, there remains a paucity of evidence-based best practice and actual GP practice in many countries, including Thailand [20–25]. Therefore, effective strategies which promote GPs' adoption of best-practice clinical guidelines for diabetes care need examination [4,8,26]. Furthermore, CME uptake by Thai GPs and the effectiveness of online diabetes CME for Thai GPs are not well understood. To understand GPs' characteristics in relation to the uptake of CME activities and familiarise GPs with mandatory CME, online diabetes CME was offered in order to examine GP uptake and test its effectiveness. Therefore, the aim of the study reported here was to investigate GP uptake of an online diabetes CME programme and its effectiveness in changing GPs' attitudes to and knowledge of T2D management. Their actual practice was not examined in this study.

2. Materials and methods

2.1. Study design and sampling

A cross-sectional descriptive study and a before-and-after study were employed to determine the uptake of the online T2D CME and test the effectiveness of the online T2D CME regarding GP trainees' changes in attitudes to and knowledge of T2D management. A follow-up survey was conducted with all those who completed the pre-test six months after this group of GP trainees completed their training to examine their CME activities, preferences and, where appropriate, their reasons for not taking this online T2D course.

The sample size was computed using WINPEPI programme version 10.8 based on the proportion of general practitioners who enrolled in online diabetes CME [15]. Assuming a proportion of 0.23, a power of 80%, and a significance level of 0.05, a total of 139 participants was sufficient to detect a 10% change in the uptake rate. In addition, assuming a power of 80%, a significance level of 0.05, and an effect size of 0.5, 34 participants were sufficient to detect a difference in knowledge score before and after completion of the online CME.

As the aims of this study were to determine the uptake of GPs of the online CME learning and test its effectiveness, we approached all 279 GP trainees in the final year of their GP training from all the training institutions in the country. We approached them because they are the first group to which mandatory CME will be applied.

2.2. Participant recruitment

The availability of this online T2D course was first advertised to GP trainees at the second compulsory workshop for GP training organised by the RCFPT. An invitation letter was distributed to the GP trainees together with details of the online programme, the option for GP trainees to participate in the before-and-after study, and the pre-test link. The GP trainees stated their interest in the online T2D course by sending their full names and email addresses to the project's research team or through the pre-survey link. An explanatory statement about the before-and-after study was provided in the first section of each test. When GP trainees signed up for the online T2D course, their usernames and passwords were automatically generated. The second round of recruitment was conducted through all the social media channels that we used to communicate with the trainees and through the email addresses the GP trainees had provided in the pre-test. To achieve a higher response rate, all participants who completed the online diabetes course and the two tests (the before and after tests) by the deadline were automatically entered into a draw to win one of 20 prizes of a 500 Baht gift voucher. All participants who completed and returned the follow-up survey by the deadline were automatically entered into a draw to win one of 20 prizes of a 300 Baht gift voucher. A total of 16 occasions of contact with the participants, in the form of reminders about completion of the before and after tests, uptake of the T2D course, and completion of the follow-up survey, were completed during the study period. In addition, evidence-based strategies known to increase recruitment to research were adopted, such as incentives and

reminders [27,28].

2.3. Educational intervention

The educational intervention was developed and designed by the authors (IT, RM) who adopted some of the steps in developing effective online learning activities proposed by Cook and Dupras [29]. The intervention, designed to provide the GP trainees with knowledge of T2D management in primary care settings, was offered for one year (September 2019 to August 2020).

The contents were designed as text-based plus interaction with text, i.e., knowledge-based quizzes and self-reflection activities. The course comprised approximately 2 h of learning activities for individuals to complete. The content of the course was developed based on the Thai Clinical Practice Guidelines for Diabetes [30], and advice from GPs and diabetes specialists. Notably, the participants could access other forms of T2D education during the study period. The content of this course could be accessed through the commercial online platform, access to which the RCFPT provided free of charge to the GP trainees and its members.

2.4. The survey instrument and data collection

A before-and-after design was used to compare the knowledge and attitudes of the GP trainees who completed the online course. The GP trainees self-selected by voluntarily choosing to enrol in the online course and participating in the before-and-after study. The questionnaires were developed by the authors (IT, RM) based on the literature [3,31], and inputs from academic GPs and experts in the field. Each item was assessed thoroughly regarding the intention of the measurement, relevance, ambiguity, understandability, and necessity, by three independent experts in medical education and academic GPs at Khon Kaen University to ensure the face and content validity of the questionnaires. The tests were conducted online and divided into two phases: pre- and post-survey. These tests included content questions in the form of multiple-choice questions, yes-no and open-ended questions, and attitudinal and knowledge questions, which were held constant across the two tests. The questionnaires were piloted with 30 GP trainees and then revised accordingly. The Cronbach's alpha coefficient of the attitude part of the questionnaire was 0.85.

The follow-up survey was used to examine the CME activities in which the GPs had participated during the six months after completing their GP training, their preferred CME methods and the CME methods they used during the six months after completing their GP training, their preferred mandatory CME topics and methods, the influence of online learning characteristics on participation in online CME, and their reasons for not taking the online T2D course.

2.5. Statistical analysis

IBM SPSS 19 for Windows version 20.0 was used for statistical analysis, and a pairwise deletion strategy was applied to handle the missing data. Descriptive statistics were used to describe the demographic data. The participant's responses on Likert scales to a six-item questionnaire on their confidence in T2D management were tallied, creating a confidence score range of 6–18. A paired-samples *t*-test was used to compare the mean difference in knowledge and confidence score among the two tests.

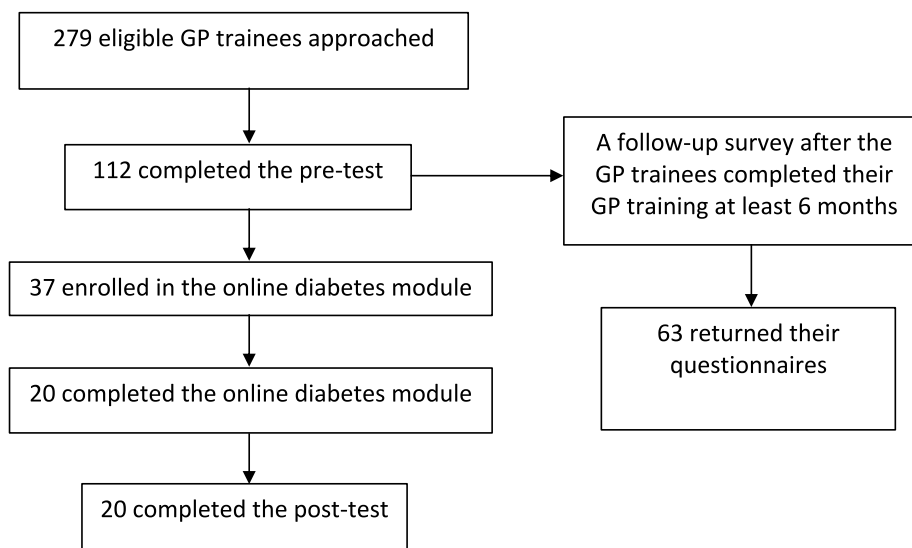


Fig. 1. Recruitment of participants.

2.6. Ethical approval

The study was approved by the Khon Kaen University Human Research Ethics Committee: Project number HE621379. The participants' return of their completed questionnaires was taken to imply consent.

3. Results

3.1. Demographics

A total of 112 out of 279 GP trainees participated in this study (response rate of 40.1%). Fig. 1 shows that 37 enrolled in the online T2D CME (13.3%), of which only 20 completed both the online programme and the post-test (7.2%). After completion of their GP training, 63 out of 112 GPs (56.3%) returned a follow-up survey. The demographic characteristics of the participants are described in Table 1.

3.2. Current type 2 diabetes management

Whilst 69.6% of the GP trainees agreed that guidelines on T2D management were useful in providing care for their patients, approximately half agreed that they kept up to date with new technology and treatment regarding T2D (Table 2).

3.3. GP trainees' confidence in managing type 2 diabetes

The respondents' confidence in the management of T2D is displayed in Table 3. They reported feeling very confident about

Table 1
Demographic data on participating GP trainees (N = 112).

| Variable | N (%) |
|--|------------------------|
| Age (years) | Mean 27.32, SD 3.17 |
| Range 24-37 | |
| <30 | 93 (83.0) |
| ≥ 30 | 19 (17.0) |
| Gender | |
| Males | 35 (31.3) |
| Females | 77 (68.8) |
| Training schemes | |
| Full-time | 46 (41.1) |
| In-service | 66 (58.9) |
| Years in general practice | |
| <3 | 83 (74.1) |
| ≥ 3 | 29 (25.9) |
| Patients seen per month | Mean 622.77, SD 521.22 |
| Range 30-2500 | |
| ≤300 | 45 (40.1) |
| 301-500 | 11 (9.8) |
| 501-700 | 16 (14.2) |
| 701-900 | 15 (13.5) |
| 901-1100 | 10 (8.9) |
| >1100 | 15 (13.5) |
| Diabetic patients seen per month | Mean 248 (SD 240.33) |
| Range 2-1500 | |
| <80 | 33 (29.5) |
| 81-180 | 14 (12.5) |
| 181-280 | 28 (25.0) |
| 281-380 | 12 (10.7) |
| 381-480 | 10 (8.9) |
| >480 | 15 (13.4) |
| Experience in online CME programme | |
| Yes | 48 (42.8) |
| No | 64 (57.1) |
| No. of total online CME programmes taken (N = 48) | |
| <3 | 42 (86.6) |
| ≥ 3 | 6 (13.4) |
| Previous online diabetes CME programmes taken (N = 48) | |
| Yes | 21 (43.7) |
| No | 27 (56.3) |

Table 2
GP trainees' current management regarding Type 2 diabetes (N = 112).

| Type 2 diabetes management items | Agree (%) | Mean (SD) |
|---|-----------|-------------|
| Guidelines on Type 2 diabetes management are useful for me in providing diabetes care for my patients | 78 (69.6) | 2.68 (0.51) |
| I keep up to date on new technology and treatment regarding Type 2 diabetes | 52 (46.4) | 2.38 (0.63) |
| At my practice, team-based approach is used for Type 2 diabetes | 48 (42.9) | 2.36 (0.61) |
| I usually apply evidence-based diabetic care in daily practice | 47 (42.0) | 2.36 (0.60) |
| I feel that my knowledge and skills are sufficient for managing diabetes | 45 (40.2) | 2.40 (0.49) |
| My practice regarding Type 2 diabetes is efficient | 38 (33.9) | 2.32 (0.51) |
| I'm confident with using brief counselling techniques including motivating behaviour change and lifestyle modifications | 36 (32.1) | 2.24 (0.59) |

Note: Mean was calculated from a three-point Likert scale ranging from 1 (disagree), 2 (not sure) to 3 (agree).

assessment, testing, and diagnosis. As illustrated in Table 4, some reported having less confidence about effective insulin treatment and managing complications; however, after completion of the online T2D CME, their confidence regarding effective insulin management increased significantly (95% CI -0.51-0.00; P = 0.05).

4. Preferences for professional educational methods

Table 5 indicates the forms of education which the respondents had completed during the previous three years from 2017 to 2019 and the type of education that they intended to undertake in the future. Regarding the GPs' preferred CME topics, the follow-up survey showed that palliative care (71.1%), care for patients with chronic diseases (71.1%), and comprehensive care in all age groups (63.5%) were the most preferred CME topics. On the other hand, 21 GPs (33.3%) rated T2D management as their preferred CME topic. During the six months after the GP trainees completed their GP training (n = 63), the number of CME activities in which they enrolled ranged from 1 to 7 (Mean 4.12, SD 1.98), and seven GPs (11.11%) enrolled in T2D CME activities.

Regarding past and predicted future usage, the most preferred education methods were different. There was an increase in the preference for interactive workshop/practice sessions with an associated increase in interactive lectures, whilst online learning was less popular. Although online mode was not the most preferred CME method, it was the most common learning method by GPs in the past six months during the COVID-19 pandemic and would be most commonly utilised if CME becomes mandatory.

5. Participants' previous experience of online learning

Eighty-four respondents (75.0%) stated that they had completed an online programme before, and some reported experiencing difficulties. About half (50.6%) stated that online learning was too time-consuming, whilst some reported that they preferred in-person instruction (37.6%) and found online programmes too difficult to use (23.5%).

5.1. Factors influencing participants' decisions to undertake the online diabetes CME

The participants reported the extent to which each factor influenced them to undertake the online T2D CME (Table 6). The need for an update on T2D management, knowledge of effective insulin treatment and use of oral medications had a strong influence, while the need to obtain CME credits had some influence.

6. Characteristics of online learning which promote participation

Participants rated the degree of influence of specific features of online learning on their participation in this mode of learning (Table 7). Flexibility, convenience, accessibility and quality of information were rated most highly by both GP trainees and GPs, whilst peer and facilitator interactions were not rated highly. In addition, the use of case-based discussion was rated more highly by the GPs compared with when they were trainees.

Table 3
GP trainees' confidence with Type 2 diabetes management (N = 112).

| Confidence with managing Type 2 diabetes items | Mean (SD) |
|---|-------------|
| Assessment, testing and making a diagnosis | 2.67 (0.47) |
| Effective use of medication: selection, monitoring and adjustment | 2.45 (0.53) |
| Assisting patients to make lifestyle changes and/or reduce risk factors | 2.44 (0.57) |
| Managing care plan and team care arrangement | 2.25 (0.58) |
| Managing complications of diabetes (e.g., eye damage, foot problems) | 2.24 (0.66) |
| Effective insulin treatment: selection, administration, monitoring and adjustment | 2.15 (0.51) |

Note: Mean was calculated from a three-point Likert scale ranging from 1 (not at all confident), 2 (partially confident) to 3 (very confident).

Table 4

GP trainees' confidence with managing Type 2 diabetes before and after enrolment in online diabetes CME (N = 20).

| Confidence with Type 2 diabetes management items | Before enrolment in course Mean (SD) | After course completion Mean (SD) | 95% CI P-value |
|---|--------------------------------------|-----------------------------------|-------------------------|
| Assessment, testing and diagnosis | 2.75 (0.44) | 2.70 (0.47) | -0.27, 0.37 P = 0.75 |
| Assisting patients to make lifestyle changes and/or reduce risk factors | 2.40 (0.59) | 2.45 (0.51) | -0.37, 0.27 P = 0.75 |
| Effective use of medications: selection, monitoring and adjustment | 2.45 (0.51) | 2.60 (0.50) | -0.46, 0.16 P = 0.33 |
| Effective insulin treatment: selection, administration, monitoring and adjustment | 2.10 (0.44) | 2.35 (0.67) | -0.51, 0.00 P = 0.05 |
| Managing complications of diabetes (e.g., eye damage, foot problems) | 2.20 (0.69) | 2.40 (0.59) | -0.52, 0.12 P = 0.21 |
| Managing care plan and care team arrangement | 2.15 (0.81) | 2.50 (0.51) | -0.81, 0.11 P = 0.13 |

Note: Mean was calculated from a three-point Likert scale ranging from 1 (not at all confident), 2 (partially confident) to 3 (very confident).

Table 5

Participants' recent and future utilisation of educational methods.

| Type of educational methods | When participants were GP trainees (N = 112) | | At least 6 months after participants completed GP training (N = 63) | | |
|--|--|--|---|--|--|
| | Frequency of each form of Type 2 diabetes education participants completed during the past 3 years (%) | Frequency of each form of Type 2 diabetes education participants would utilise in the future (%) | Frequency of each form GPs completed during the past 6 months (%) | Frequency of each form GPs would utilise in the future (%) | Frequency of each form GPs would utilise if CME were mandatory (%) |
| Interactive workshop/practice sessions | 40 (35.7) | 77 (68.8) | 24 (38.1) | 36 (57.1) | 19 (30.2) |
| Interactive lecture | 40 (35.7) | 62 (55.4) | 24 (38.1) | 38 (60.3) | 27 (42.9) |
| Computer-based internet | 64 (57.1) | 57 (50.9) | 37 (58.7) | 31 (49.2) | 48 (76.2) |
| Textbook | 68 (60.7) | 51 (45.5) | 30 (47.6) | 32 (50.8) | 10 (15.9) |
| Print materials | 41 (36.6) | 40 (35.7) | 24 (38.1) | 26 (41.3) | 10 (15.9) |
| In-person conference | 38 (33.9) | 22 (19.6) | 21 (33.3) | 24 (38.1) | 14 (22.2) |
| Computer-based CD/DVD | 1 (0.9) | 16 (14.3) | 6 (9.5) | 12 (19.0) | 3 (4.8) |
| Interactive video conference | 1 (0.9) | 11 (9.8) | 35 (55.6) | 25 (39.7) | 22 (34.9) |
| None | 2 (1.8) | - | 1 (1.6) | - | - |

Table 6

Factors influencing GP trainees' uptake of this online CME (N = 112).

| Variable | Degree of influence on undertaking this online programme Mean (SD) |
|---|--|
| Need for update on type 2 diabetes management | 2.88 (0.33) |
| Need for knowledge of effective use of oral hypoglycaemic agents | 2.88 (0.33) |
| Need for knowledge of effective insulin treatment | 2.88 (0.32) |
| Need to update clinical knowledge regarding screening, assessment and diagnosis | 2.81 (0.39) |
| No cost to complete the online CME programme | 2.78 (0.48) |
| Convenience of completing the online CME programme | 2.70 (0.48) |
| Use of new technology for learning | 2.60 (0.54) |
| Need to obtain CME credits | 2.34 (0.69) |

Note: Mean was calculated from a three-point Likert scale ranging from 1 (not at all), 2 (to some extent) to 3 (to great extent).

7. Participants' knowledge of type 2 diabetes management

The mean total knowledge score for all respondents (N = 112) in the pre-test was 16.2 (SD 2.55, range 5.74–21.93) out of a maximum total score of 26, producing a mean total knowledge score of 61.5%. Comparing pre-and post-test scores (N = 20), the pre-online T2D CME mean knowledge score was 16.50 (SD 2.76), whilst the mean knowledge score post-online T2D CME was 18.18 (SD 4.28), with no statistical difference between these scores (95% CI, -3.93-0.59; P = 0.14).

Table 7
Participants' ratings of influence of online learning characteristics on participation in online CME.

| Variable | Degree of influence on undertaking the online course | |
|---|--|---|
| | Participants when they were GP trainees (N = 20) Mean (SD) | Participants at least 6 months after completion of GP training (N = 63) Mean (SD) |
| Quality of information available online | 2.95 (0.22) | 2.89 (0.32) |
| Ease of access via the internet | 2.95 (0.22) | 2.81 (0.47) |
| Ease of use | 2.95 (0.22) | 2.78 (0.46) |
| Convenience of completing the course at any time or location | 2.95 (0.22) | 2.81 (0.47) |
| Flexibility to complete small section at a time | 2.95 (0.22) | 2.83 (0.38) |
| Immediate access to correct answers when completing quizzes | 2.90 (0.31) | 2.63 (0.58) |
| Ease of obtaining CME credit | 2.85 (0.37) | 2.68 (0.53) |
| Access to other useful links | 2.80 (0.52) | 2.89 (0.36) |
| Access to technical support if difficulties are encountered | 2.80 (0.41) | 2.71 (0.49) |
| Use of case-based discussion | 2.55 (0.51) | 2.71 (0.49) |
| Facilitator's regular input/participation | 2.55 (0.51) | 2.56 (0.50) |
| Opportunity to communicate/interact with instructors or peers | 2.35 (0.75) | 2.32 (0.64) |

Note: Mean was calculated from a three-point Likert scale ranging from 1 (no influence), 2 (some influence) to 3 (major influence).

8. Participants' experience of the online diabetes CME programme

Most of the respondents agreed on the advantages of the online programme. They endorsed the following statements: they were able to learn at their own pace; they received enough instruction in the use of the module; overall, the content was clear and easy to understand (Table 8). More than half of the GP respondents who did not enrol in the online T2D course reported they had not heard about the programme (Table 9).

9. Discussion

9.1. CME uptake among Thai GP trainees

This is the first study to describe the uptake of online CME in T2D education by GP trainees in Thailand. The results of the present study are limited by the low response rate and high attrition rate. While the low response rate applied to GP trainees' recruitment to the online CME and the post-test, the high attrition rate also applied to the completion of the online CME and the before-and-after study. Evidence-based strategies to improve the recruitment of GPs to the CME programme and to increase the response rate were adopted, including reminders and monetary incentives [27,28]. Despite these efforts, the response rates to the online CME and the before-and-after study remained low. These limitations mean that the findings need to be interpreted cautiously.

That only a small number of GP trainees completed the online diabetes CME is perhaps unsurprising, as other studies have reported difficulty in recruiting GPs for online education [15,28,32]. Possible explanations for the poor uptake are as follows. Firstly, online education was not the most preferred educational delivery method for T2D education among the Thai GP trainees and would not be the most popular CME method for GPs in the future. The preference for CME delivery methods has been explored previously, and

Table 8
GP trainees' learning experience on this online course (N = 20).

| Variable | Mean (SD) |
|--|-------------|
| I received adequate help with technical problems | 2.95 (0.94) |
| I was able to learn at my own pace | 2.90 (0.30) |
| Overall, the content was clear and easy to understand | 2.70 (0.47) |
| The programme met my learning needs for Type 2 diabetes management | 2.60 (0.50) |
| The content was clear and covered all the course objectives | 2.60 (0.59) |
| Overall, the instruction I received through this programme was motivating | 2.55 (0.68) |
| I received enough instruction in the use of the programme | 2.45 (0.75) |
| I was able to immediately access feedback and correct answers when completing quizzes or contact the facilitator | 2.45 (0.60) |
| I was more comfortable participating in discussions in this programme than I am in face-to-face courses | 2.20 (0.69) |
| The program provided too much simple well-known information | 2.00 (0.56) |
| I spent too much time accessing the programme on the computer | 1.85 (0.81) |
| The programme took too long to complete | 1.75 (0.78) |
| I spent too much time waiting for external links to download | 1.70 (0.73) |
| The internet connection was very slow | 1.55 (0.68) |
| I felt that I did not possess adequate computer skills to complete the module | 1.35 (0.67) |

Table 9
GPs' reasons for not undertaking the online diabetes CME program (N = 63).

| Variable | N (%) |
|---|-----------|
| I did not hear about this online programme | 43 (68.3) |
| Not enough time to complete the online programme | 14 (22.2) |
| I don't know how/where to get started with this online programme | 14 (22.2) |
| Not interested in the topic | 5 (7.9) |
| I had already completed the programme | 5 (7.9) |
| Have recently completed CME on this topic | 4 (6.3) |
| I prefer face-to-face activities | 4 (6.3) |
| I have commenced the programme but not yet completed it | 3 (4.8) |
| I feel I have sufficient knowledge and training to manage type 2 diabetes | 2 (3.2) |
| I don't like online learning due to the lack of social/peer interaction | 2 (3.2) |
| Poor or no internet access | 0 (0.0) |

face-to-face activities remain the most frequently used and preferred method of CME for GPs [33–35]. In addition, the results of the present study show that interactive lectures are more desirable than interactive videoconferencing. These explanations may be due to the high cost and lack of interest of GPs in the use of videoconferencing [36,37], whilst lectures remain the most popular CME format for GPs [3,33,38].

Secondly, the major difficulty with online CME learning is that it is perceived to be time-consuming. In terms of time, two aspects may be relevant. The first is the time constraint. GPs are busy with their routine practice which was previously reported as one of the barriers to online CME [35,39]. Another aspect is time consumption, as a result of the online CME programme's considerably long duration [15]. Since trainee GPs are very busy with their studies and routine practice, they have to manage their time after hours for online learning. On the other hand, they can ask for educational leave to attend face-to-face learning activities such as conferences. In addition, most in-person instruction CME activities take place over a short period, unlike asynchronous online learning, which mostly takes longer. Note that the present study shows that, in relation to the GPs' learning preferences and needs, the online method was not their preferred choice. However, if CME is mandatory, online would be their first option, and in the future, the acceptance of computer-based internet or online education will increase markedly worldwide [16,40–42]. Therefore, if they must undertake CME to maintain their registration, the most flexible and suitable method to adopt for their busy practice may be online.

Thirdly, the instructional design of online CME may not contribute to learning. All instructional designs, namely, content presentation only, interaction with content, and interpersonal interaction, are mostly supported by online learning platforms [43]. Interactive instructional designs in online learning aim to engage the active participation of the learners. Although evidence suggests that interactive instructional designs such as self-assessment questions and practice exercises of online CME could improve learning outcomes [44,45], and quizzes and self-reflection activities were employed in our present study, they did not encourage learners to complete the online course in this instance. A systematic review and meta-analysis found that strategies to enhance learner participation in an online course included the provision of printed course guides and technical support, the use of a Web server instead of a complicated learning management system, and making the course integral to the curriculum [45], and these strategies were adopted in our present study. Therefore, in the present study, effective instructional design and educational methods did not encourage online CME uptake or completion.

Fourthly, the most common reported reason for not participating in the T2D online course in the present study was that the GPs did not know about the programme, although recruitment strategies were employed using all the channels which the RCFPT use to communicate with their members. A possible explanation may be that these recruitment strategies may not be sufficient or suitable for both GP trainees and GPs. In addition, the diabetes topic was not the topic most needed by the trainees. There is, therefore, a need to explore the learning needs of the target learners as well as more effective recruitment strategies [46], particularly to online CME [3].

The results of the pre-test in this present study showed that the GPs had insufficient knowledge of T2D management. Despite accessibility to CME activities through online learning, the GPs' uptake of CME was low. Therefore, mandatory CME is needed initially to increase the number of GPs taking CME activities and ultimately to close the gap between evidence-based and actual GP practice. However, evidence shows low uptake of online CME in many countries, including those where CME is already mandatory [15]. Possible explanations may be that since diabetes is one of the most common conditions managed in primary care [47], GPs routinely manage this problem and may not realise that their knowledge is not up to date according to evidence-based practice [31]. Therefore, more rigorous research studies are needed to convince GPs that they lack knowledge of T2D management and emphasize their educational needs on this topic. In addition, strategies to promote and emphasize the importance of CME are worth exploring.

In Thailand, the use of information and communication technologies for the provision of CME to rural and remote GPs is crucial. Similar to other countries, there is a lack of continuing education opportunities in rural and remote areas [15,48,49]. Online education methods have been particularly helpful in increasing access to CME. However, educational needs and barriers to online learning for this group of learners need to be further explored [48].

9.2. Effectiveness of online CME

The poor uptake of the GP trainees of the T2D education programme was possibly because they believed that their current T2D knowledge was sufficient, and therefore, no further education was needed. However, the mean knowledge score for the group before

attending the online T2D CME was just above half of the total knowledge score. In addition, only half of the participants reported keeping up-to-date on the technology for and treatment of type 2 diabetes.

The effects of the online CME identified in the present study are consistent with the modified form of medical education proposed by Kirkpatrick [12,50,51], namely, satisfaction, learning, performance, and patient/health outcomes [12]. The aim of the present study was to test the effectiveness of online T2D CME on participants' attitudes and knowledge. There was no statistically significant change in knowledge before and after the online T2D programme. However, we found a significant difference in their confidence in the area of effective insulin treatment, which was the area responding to their educational needs. In addition, the participants were satisfied with their experience with this online learning. Therefore, in the present study, the effectiveness of online T2D CME can be seen in the learners' satisfaction with and confidence in the management of T2D but it did not affect their knowledge. The latter effect may be due to the small number of participants, which was not sufficient to detect differences. Although most of respondents were partially or very confident with the management of Type 2 diabetes, they were unsure about their self-efficacy in managing type 2 diabetes. Possible explanations include, firstly, that less than half agreed that they applied evidence-based diabetic care in daily practice. Secondly, less than half agreed that they had sufficient current knowledge and the total mean knowledge score on the pre-test was just above half. It is dangerous to have confidence in practice without sufficient knowledge [31]. Nevertheless, the present study highlights the importance of mandatory CME for Thai GPs, as there is a gap between evidence-based practice and actual GP practice.

10. Development and implementation of online CME

Although we followed some evidence-based steps to develop an effective online CME programme [4,29,52], a possible flaw in our study may have been the initial and crucial step of identifying GPs' learning needs. Learning needs assessment for CME for Thai community doctors and nurses was used to guide the topics and contents [19], but the GP trainees who were the target group in the present study may have different access to educational programmes and resources. This may have made the needs analysis less relevant to the audience which ultimately received the online T2D CME.

The contents of the topics were developed based on evidence-based practice guidelines, and the GP trainees reported positive attitudes about the T2D guidelines. However, the use of the guidelines did not correlate with their level of knowledge. Although GPs may be familiar with the guidelines, this does not necessarily mean that they implement the associated recommendations in their day-to-day clinical practice. Therefore, a future study needs to explore the adoption of guidelines by GPs and how they implement the recommendations of guidelines in their routine practice. Furthermore, barriers to adopting and implementing guidelines are worth exploring.

To improve the recruitment of GPs for CME, the delivery methods need to serve GPs' preferences. Although the respondents in the present study indicated their preference for face-to-face T2D CME, given the benefits of online CME for rural and remote GPs, a trend to utilising online learning in the future, and its availability during the COVID-19 pandemic, online CME may be used as a complementary mode to face-to-face learning to provide mandatory CME activities for Thai GPs in future [13]. In addition, multi-faceted interventions and reinforcement from different sources are likely to be the most effective educational methods for GPs [1,53].

To increase the uptake of online CME, there is a need to consider the characteristics of online learning which promote participation, including the convenience and flexibility of online learning methods, content quality, and case-based discussion. The quality of the content is associated with the acceptance of online learning [54], and case-based discussion is familiar to GPs, as it is primarily a form of formative assessment to assess the progress of learning by GP trainees using feedback on the learner's performance [55]. Although evidence suggests that online discussion has a non-significant effect on learning outcomes, learners' satisfaction with this mode of learning is promising [45,56].

Although the interactive format was not found to be the focus of this group of participants, instructional designs need to be considered based on the objectives of the educational topics. Furthermore, online CME needs to serve the needs of the targeted participants, as previous studies have reported that mandatory CME does not warrant the uptakes of any CME activities [15,32]. Hence, there is a need to adopt evidence-based strategies which suit different educational and healthcare systems in the development and implementation of CME activities.

11. Limitations

The limitations of this present study need to be acknowledged. Firstly, the sample size of the GP trainees enrolled in the online T2D CME and the before-and-after study was small. This means that the findings need to be interpreted with caution. Secondly, the study did not exclude any additional education or training the GP trainees might have received during their enrolment in the online T2D course. Therefore, the knowledge scores might not reflect solely the effects of the T2D course. Even if some of the participants might enrol in other diabetes CME at the same time as our course, their knowledge scores after our course did not change statistically compared to their knowledge before the course. This means that they still lack knowledge of Type 2 diabetes and thus warrant mandatory CME. The present study followed this group of GP trainees until they became GPs at least six months after they completed their training. However, once mandatory CME is established in Thailand, it will be worth studying the educational need for, attitudes to and uptake of, online CME for GPs who have worked for several years after graduation.

12. Conclusions

There was poor uptake of an online diabetes CME, although evidence-based recruitment strategies were employed, and the online

educational option is attractive and accessible during the COVID-19 pandemic. This study may not be able to close the gap between evidence-based practice and actual GP practice due to the low uptake of CME. However, the GPs' insufficient knowledge confirms this existing gap and warrants mandatory CME. The present study therefore emphasises not only the gap between evidence-based practice and actual GP practice but also the need for mandatory CME. To improve GPs' uptake of diabetes CME, considering the benefits of online CME and GPs' preferences for educational methods, online learning may be used to complement rather than replace traditional CME.

Declarations

Author contribution statement

Isaraporn Thepwongsa: conceived and designed the experiments; performed the experiments; analysed and interpreted the data; contributed reagents, materials, analysis tools or data; wrote the paper

Radhakrishnan Muthukumar: conceived and designed the experiments; performed the experiments; analysed and interpreted the data; contributed reagents, materials, analysis tools or data; wrote the paper

Poompong Sripa: analysed and interpreted the data; contributed reagents, materials, analysis tools or data; wrote the paper

Leon Piterman: analysed and interpreted the data; contributed reagents, materials, analysis tools or data; wrote the paper

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Data availability statement

The data from this research project are available on request.

Competing interest statement

No potential conflict of interest relevant to this article was reported.

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