Challenges and support factors in managing type 2 diabetes among pregnant women in Thailand: A convergent mixed-methods study

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Abstract

Background: Sociocultural and behavioral factors have a multifaceted impact on maternal health. In Thailand, cultural influences significantly shape behaviors of diabetes self-management in women. However, the experience of self-managing diabetes in pregnant women with preexisting Type 2 Diabetes Mellitus (T2DM) remains unclear.

Objectives: The study aimed to explore challenges and support factors of diabetes self-management among pregnant women with preexisting T2DM in Thailand, and to compare these factors between women in two groups (optimal and suboptimal maternal health outcomes).

Methods: A convergent mixed-methods study was conducted at a tertiary hospital (March to October 2022). Eligible participants were Thai pregnant women, aged 20-44, diagnosed with T2DM. Participants first completed a questionnaire and then were interviewed about diabetes self-management. Maternal health outcomes (i.e., gestational weight gain and glycated hemoglobin [HbA1c]) were reviewed and extracted. Descriptive statistics were used for quantitative analysis, while directed content analysis was used for qualitative data. Side-by-side matrices were used to describe the qualitative subthemes with quantitative results.

Results: Twelve Thai pregnant women participated in the study, aged 27 to 40 years, with gestational ages ranging from 7 to 38 weeks and T2DM diagnoses spanning from 3 weeks to 10 years. Half of the participants were obese before pregnancy. Weight gain patterns revealed that 41.67% had inadequate gain, 33.33% had optimal gain, and 25% had excessive gain. HbA1C levels indicated that 75% had good glycemic control. Three women achieved optimal weight gain and glycemic control, while nine exhibited suboptimal health outcomes. We identified six main themes: 1) challenges at the individual level in managing diabetes, 2) support factors at the individual level for diabetes management, 3) challenges at the interpersonal level in controlling diet, 4) interpersonal support factors for managing diabetes, 5) challenges at the societal level in accessing healthcare, and 6) societal support factors for healthcare access.

Conclusion: The findings suggest that managing diabetes during pregnancy necessitates dynamic, patient-centered care throughout the pregnancy journey. Regarding the clinical implication, it is important to tailor approaches to the Thai context and to prioritize education and boost women's confidence in managing diabetes throughout pregnancy.

Keywords

Background

In Thailand, compared to men (8.9%), diabetes prevalence is higher among women (10.8%) (Aekplakorn et al., 2018). The incidence of preexisting type 2 diabetes mellitus (T2DM) among women of reproductive age has been rising. Compared to women with gestational diabetes mellitus (GDM), women with T2DM experience higher rates in developing maternal

complications such as pre-eclampsia (Persson et al., 2016) and miscarriage (Mukerji et al., 2020). In women with T2DM, inadequate glycemic control (i.e., HbA1C > 6.5%) raises the risk of preterm labor (Buhary et al., 2016). Infants born to women with inadequate glycemic control often have heavier birth weights, experience more frequent hypoglycemic episodes, and are more likely to be admitted to the Neonatal Intensive Care Unit (Bellg et al., 2004) compared to infants of women with well-managed glycemic levels (Buhary et al., 2016). Therefore, pregnant women with T2DM need to manage their blood sugar levels to reduce the risk of complications (Alexopoulos et al., 2019). The nurse's role is to educate, guide, and support pregnant women in adhering to and coordinating care to ensure optimal outcomes for both mother and baby.

The sociocultural environment and behavioral factors influence maternal health in intricate and multi-dimensional ways (Alvidrez et al., 2019). Thai culture frequently influences women's diabetes self-management behaviors, acting as either a supportive element or a potential obstacle (Auemaneekul et al., 2016; Sowattanangoon et al., 2009). For instance, a typical challenge is that Thai meals traditionally include rice, which makes it difficult to restrict carbohydrates for effective diabetes management (Auemaneekul et al., 2016; Sowattanangoon et al., 2009). Cultural traditions have called for pregnant women to take various precautions, such as refraining from vigorous activities, to protect the health and well-being of their unborn babies (Liamputtong & Kitisriworapan, 2014). Maintaining optimal glycemic control requires balancing these traditional precautions with effective diabetes self-care practices (American Diabetes Association, 2023).

A recent review on the challenges and support factors in managing T2DM during pregnancy revealed that most prior studies were conducted in Western countries (Phonyiam, 2022). Moreover, many studies reported a mix of experiences among pregnant women with T1DM, T2DM, and GDM, which limited the applicability of the findings specifically to the T2DM group (Phonyiam, 2022). Recognizing that experiences of diabetes self-management may differ for pregnant women with preexisting T2DM compared to those with T1DM and GDM will help us understand how the nurse can intervene to provide best quality of education for this population. We aimed to address this knowledge gap by exploring challenges and support factors specific to Thai pregnant women with preexisting T2DM.

Methods

Study Design

A convergent parallel, qualitatively oriented, mixed-methods design was used (Creswell & Creswell, 2018). Qualitative and quantitative data were gathered and analyzed both independently and simultaneously. This mixed-methods approach aimed to comprehensively capture different aspects of diabetes self-management during pregnancy, enhancing understanding by comparing and integrating both types of findings. This research is part of the first author's dissertation (Phonyiam, 2024).

In this study, qualitative methods were primarily used to answer the research questions, with quantitative data providing supplementary information to enrich the qualitative findings (Phonyiam et al., 2023). The specific aims were to: 1) qualitatively investigate challenges and support factors faced by Thai pregnant women with preexisting T2DM, 2) quantitatively categorize optimal and suboptimal maternal health outcomes among these participants, and 3) integrate both quantitative and qualitative data to determine if women with optimal and suboptimal outcomes experienced different challenges and support factors.

Following the National Institute on Minority Health and Health Disparities (NIMHD) Framework, this study systematically provided insights into the individual, interpersonal, community, and societal levels across multiple domains of influence, including biological, behavioral, physical/built environment, sociocultural environment, and health care system (Alvidrez et al., 2019). The integration of the theoretical framework was evident throughout the study design, data collection, data analysis processes, and presentation of results.

Samples/Participants

This study was conducted at a hospital in Bangkok, Thailand, from March 2022 to October 2022. The first author and Research Assistant (RA) collaborated with registered nurses at antenatal clinics to identify potential participants from electronic health records based on the eligibility criteria.

The inclusion criteria for the study were pregnant women with preexisting T2DM, either primigravida or multigravida, aged 20 to 44 years, who could speak Thai and provide informed consent. Participants were excluded if they had significant complications, such as blindness, or life-threatening illnesses, such as myocardial infarction, as these conditions would necessitate advanced diabetes treatments. Recruitment was conducted through face-to-face outreach at the clinic or via phone. Women who met the eligibility criteria were scheduled for a semi-structured interview at a time that was convenient for them (see **Figure 1**).

As this study was a qualitative-oriented mixed-methods study (Creswell & Creswell, 2018), the sample size was determined based on the principle of data saturation in the qualitative component, where data collection continued until no new themes emerged (Lincoln & Guba, 1985). For example, when participants repeatedly discussed similar topics, such as individual-level challenges to diabetes management, as mentioned by others, the data were deemed sufficient to reach saturation (Lincoln & Guba, 1985). Since the quantitative data aimed to complement the qualitative findings, the same participant pool was utilized, allowing researchers to integrate the data from both components (Creswell & Creswell, 2018).

To enable cross-case comparison, the participants were divided into two groups: those with optimal health outcomes and those with suboptimal health outcomes (Guetterman et al., 2015), guided by predefined health indicators, including gestational weight gain and glycemic control (American Diabetes Association, 2023).
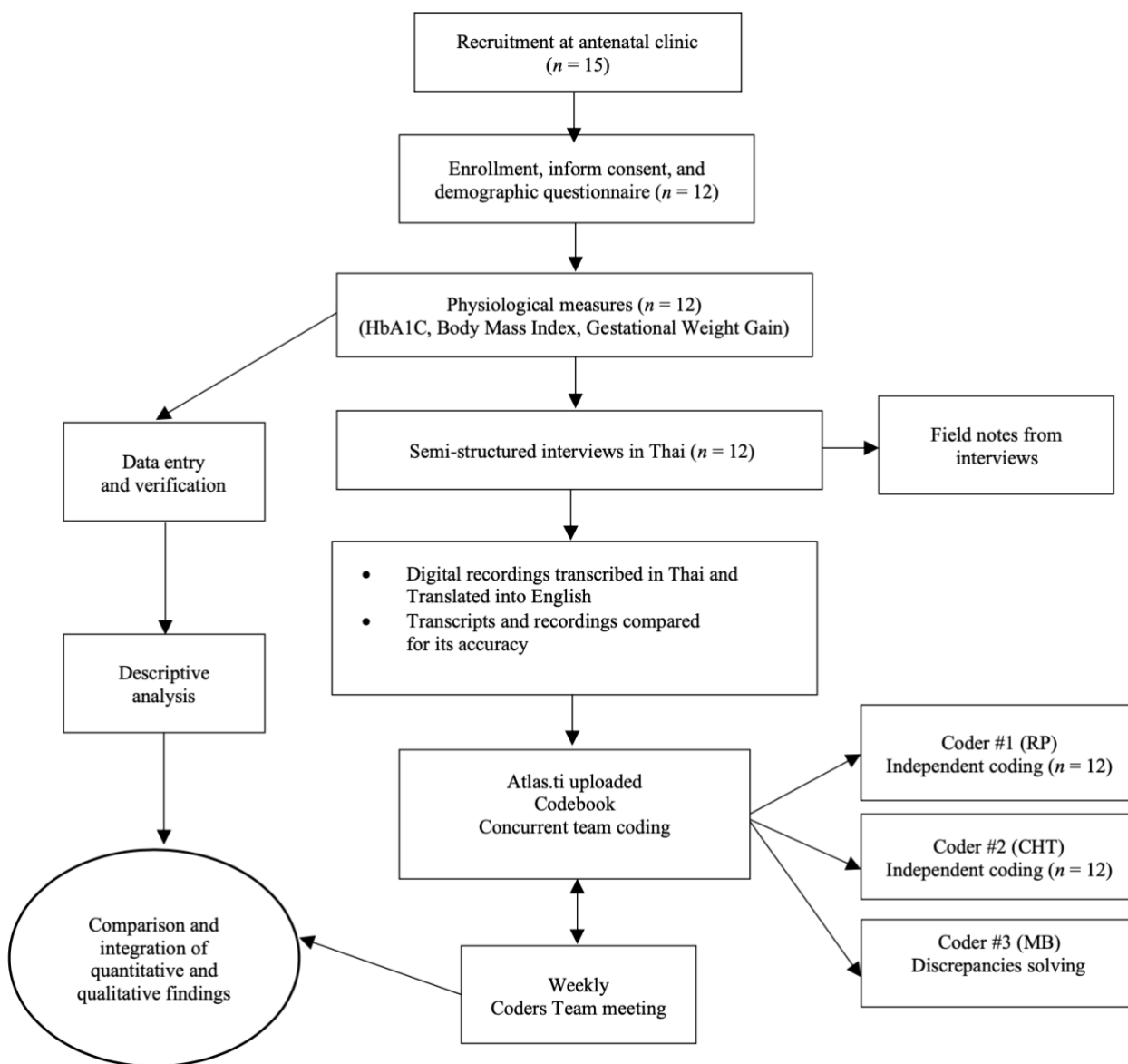
Figure 1 Data collection and analysis procedure

Data Collection

Participants completed a demographic questionnaire via the Research Electronic Data Capture (REDCap) mobile link. We collected maternal health outcomes from the women's electronic health records (EHR) at each antenatal care (ANC) visit, both retrospectively and prospectively, based on their gestational age on the enrollment day (Phonyiam et al., 2023). Thai women were advised and encouraged to attend at least four visits as part of the focused ANC (FANC) model at 8–12 weeks, 24–26 weeks, 32 weeks, and 36–38 weeks of gestation.

Maternal health outcomes included women's weight (in kilograms; kg), height (in meters; m), body mass index (BMI), gestational weight gain (GWG; kg), and HbA1C levels (%). To calculate GWG, we subtracted the baseline body weight from the immediate pre-delivery body weight. We then categorized pregnant women's GWG according to their pre-pregnancy BMI, following the guidelines from the Diabetes Association of Thailand (see **Table 1**). Pregnant women with lower GWG were classified as having inadequate GWG, while those with higher GWG were classified as having excessive GWG

(Diabetes Association of Thailand, 2017). Women's HbA1C levels were obtained from their medical records at two time points: prior to pregnancy and during the antenatal care visit at 24 to 26 weeks.

Table 1 Recommendations for gestational weight gain

BMI Category	Pre-pregnancy BMI (Kg/m^2)	Optimal GWG (Kg)
Underweight	<18.5	12.5-18
Normal	18.5-24.9	11.5-16
Overweight	25.0-29.9	7-11.5
Obesity	≥30	5-9

Source: (Diabetes Association of Thailand, 2017)

To minimize the risk of COVID-19 infection, women had the option to complete the interview via phone, a Zoom call without video, or in person. The first author conducted these semi-structured interviews, with questions guided by the NIMHD framework (Alvidrez et al., 2019) which focused on challenges and support factors for diabetes self-management at the individual, interpersonal, community, and societal levels.

Data Analysis

Qualitative data. Using an iterative process, data analysis occurred concurrently with data collection. The interview translation process was as follows: first, the first author transcribed the audiotape verbatim in Thai. De-identified interviews were then sent to a bilingual professional translation service for translation into English. The first author re-read both the Thai and English versions to ensure consistency and accuracy in the transcripts. English transcripts were analyzed since our coding team included both Thai-speaking and non-Thai-speaking researchers. To maintain the rigor of cross-language data analysis, the first author documented "atypical words," such as jargon and slang, encountered in each transcript (Al-Amer et al., 2015). English transcripts were analyzed using Atlas.ti version 9 (Atlas.ti Scientific Software GmBH, Berlin, Germany). We used direct content analysis (Hsieh & Shannon, 2005). We used the NIMHD framework's components as the initial codes (e.g., sociocultural environment) (Alvidrez et al., 2019). Salient data that could not be coded with these initial codes from the NIMHD's components were created into new codes (Hsieh & Shannon, 2005). Themes were categorized as challenges and support factors for diabetes management across various levels of influence, including individual, interpersonal, community, and societal. Subthemes were guided by different domains of influence, such as biological, behavioral, physical/built environment, sociocultural environment, and health care system. A codebook containing code names, definitions, and examples was created, revised, and updated as necessary throughout the coding process.

Three coders participated in the data analysis, with two coders independently coding each interview transcript. We aimed to code one interview transcript per week, and the two coders held weekly meetings to discuss their coding and update the codebook as necessary. The analysis involved a constant back-and-forth process between the entire dataset and individual transcript coding. Throughout the data analysis, coders maintained a log with memos and ideas for discussion in their meetings. A senior researcher acted as the third coder to resolve any discrepancies. The three coders met regularly to discuss findings and assess the amount of new information from subsequent interviews to confirm when data saturation had been reached. The final interview was conducted at the 12th interview, which indicated that an appropriate sample size had been achieved (Lincoln & Guba, 1985).

Quantitative data. Data from the questionnaire and physiological measures were analyzed using IBM SPSS version 25.0 software (IBM Corp, Released 2017). We calculated the means, standard deviations, and ranges for each continuous variable, while frequencies and percentages were tabulated for each categorical variable (e.g., maternal health outcomes). Missing data were addressed using imputation, which involved substituting values for any missing data points (Wirtz et al., 2021). For HbA1C, we used item mean imputation. This method of imputing glycemic indicators like HbA1C has been commonly applied in previous studies, demonstrating that the means of the imputed data were consistent with the observed data (Buhary et al., 2016). For example, if a participant had missing data, it was substituted with the mean value derived from all the other respondents' data (Wirtz et al., 2021).

Mixed methods. We employed a cross-case comparison joint display to present the qualitative themes and subthemes alongside the quantitative results related to maternal health outcomes, effectively illustrating the findings from both approaches and highlighting their integration (Guetterman et al., 2015). We categorized women into two groups: those with optimal health outcomes and those with suboptimal health outcomes. Women who maintained good glycemic control (HbA1C less than 6.5%) and achieved optimal gestational weight gain (GWG) based on their pre-pregnancy BMI were classified as having "optimal health outcomes." The remaining women were designated as having "suboptimal health outcomes." We compared each subtheme, supported by quotations from both groups, to provide a comprehensive summary of challenges and support factors affecting diabetes management during pregnancy. Our findings included both convergent and divergent results, depending on whether the subthemes aligned with or contradicted women's health outcomes. When divergent findings occur, the researchers are suggested to discuss the potential discrepancies between their quantitative and qualitative results and how the divergence provides additional insight into the problem being studied (Creswell & Creswell, 2018).

Ethical Consideration

The Institutional Review Boards from two universities approved all procedures, study materials, and personnel prior to the study's implementation (IRB 21-1477 from the University of North Carolina at Chapel Hill, United States, and IRB 3428 from Mahidol University, Thailand). The study methods were carried out in accordance with the approved study protocol (Phonyiam et al., 2023). Written informed consent forms were obtained from all participants.

Results

Participant Characteristics

Twelve Thai pregnant women with preexisting T2DM participated in this study. Their ages ranged from 27 to 40 years, and all were married. Half of the participants had a bachelor's degree or higher, and approximately 42% were employed in government or state enterprises. Monthly household incomes varied from 10,000 to 70,000 Baht. At the time of enrollment, the participants' gestational ages ranged from 7 to 38 weeks, and their diagnoses of T2DM were between 3 weeks and 10 years.

Maternal Health Outcomes

Of the 12 participants, half were classified as obese based on their pre-pregnancy BMI. In terms of weight gain up to the time of delivery, 41.67% experienced inadequate gain, 33.33% had optimal gain, and 25% gained excessively. For glycemic control, 75% of participants achieved good control, with HbA1C levels below 6.5% (see **Table 2**).

Among all participants, 3 women achieved both optimal weight gain and good glycemic control, reflecting optimal health outcomes. The remaining 9 women were classified as having suboptimal health outcomes, attributed to either inadequate or excessive weight gain and/or poor glycemic control.

Table 2 Maternal health outcomes (*N* = 12)

Variable	% (*n*)
Pre-Pregnancy Body Mass Index	
Normal	8.33 (1)
Overweight	41.67 (5)
Obese	50.00 (6)
Gestational Weight Gain	
Inadequate	41.67 (5)
Optimal	33.33 (4)
Excessive	25.00 (3)
HbA1C	
Good glycemic control: less than 6.5%	75.00 (9)

Qualitative Findings

Six main themes were found: 1) challenges at the individual level in managing diabetes, 2) support factors at the individual level for diabetes management, 3) challenges at the interpersonal level in controlling diet, 4) interpersonal support factors for managing diabetes, 5) challenges at the societal level in accessing healthcare, and 6) societal support factors for healthcare access.

Using the NIMHD framework (Alvidrez et al., 2019), our findings presented a matrix illustrating three levels of influence (individual, interpersonal, and societal) across five domains of influence (biological, behavioral, physical/built environment, sociocultural environment, and health care system) (see **Figure 2**). The subthemes identified as challenges (-) and support factors (+) were indicated. Notably, no participants shared experiences related to the community level. We found that the subthemes were more frequently reported at the individual level, particularly within the biological, behavioral, and health care system domains. Additionally, subthemes emerged at the interpersonal level across four domains, as well as at the societal level specifically within the health care system domain.

		Level of influence		
		Individual level	**Interpersonal level**	**Societal level**
Domain of influence	**Biological**	**Challenges** • Episodes of hypoglycemia during pregnancy	NR	NR
	Behavioral	**Challenges** • Challenges in diabetes management during pregnancy **Support factors** • Positive motivation and mindset shift for diabetes management	**Support factors** • Family members helped adjust pregnant women's eating behaviors and stress reduction	NR
	Physical and built environment	NR	**Support factors** • Workplace environment facilitates diabetes care	NR
	Sociocultural environment	NR	**Challenges** • Food environment within the family unit **Support factors** • Physical and emotional support and experience sharing from colleagues, peers, and social networks	NR
	Health care system	**Challenges** • Lack of health literacy on proper aseptic technique for insulin injection **Support factors** • Health literacy on insulin dose adjustments and optimal blood sugar level	**Support factors** • Guidance and support from health care providers in medical decision-making and dietary education	**Challenges** • Challenges with health insurance and the high cost of medical supplies **Support factors** • Comprehensive health care support: glucometers, facilities, referrals, and interdisciplinary care
	Health outcomes	Glycemic control Gestational weight gain	NR	NR

Figure 2 Using the NIMHD domains and levels of influence across qualitative subthemes

Note: NR: not reported

Theme 1: Challenges at the individual level in managing diabetes

There were three subthemes across three domains of influence: biological, behavioral, and health care system. In the biological domain, one subtheme is glucose regulation during pregnancy. Specifically, those women during pregnancy experienced hypoglycemic episodes (i.e., blood sugar levels ranging from 60 to 86 mg/dL). They reported symptoms including light-headedness, dizziness, and shaky hands during these episodes.

In the behavioral domain, women reported facing challenges in managing their diabetes during pregnancy. They found it difficult to limit certain foods because of pregnancy cravings, particularly for items like fruits, ice cream, and rice. Additionally, they experienced reduced physical activity due to fatigue and concerns about the risk of miscarriage. Managing blood sugar testing and insulin injections around mealtimes also posed significant challenges for them. An example was that a participant described she tended to be hungrier especially as they approached the later stages of pregnancy. Second, feelings of tiredness, fatigue, and heaviness, coupled with fears of miscarriage, made pregnant women less inclined to participate in physical activity. None of the participants reported doing any rigorous exercise; instead, their physical activity primarily consisted of light walking while shopping, climbing stairs, and performing regular household chores. For example, ID014 shared that she walked lightly during 12-week pregnancy. She was afraid to walk fast. Third, participants faced challenges in managing the timing of blood sugar tests and insulin injections around mealtimes. Despite feeling hungry, they had to wait 15 minutes after administering their insulin before they could eat. ID006 shared that she had to keep track of the time to incorporate the mealtime and insulin injection.

In the healthcare system domain, a few women raised questions during the interview, suggesting a possible lack of health literacy regarding proper aseptic techniques for insulin injection. For example, one question was whether they needed to replace the needle each time.

Theme 2: Support factors at the individual level for diabetes management

Two subthemes were identified. The domains of influence include the behavioral and health care system. In the behavioral domain, women reported a positive shift in motivation and mindset regarding their diabetes management. Many participants expressed a strong desire to control their T2DM when they thought about their babies' health. They feared that elevated blood sugar levels could negatively impact their babies, which fueled their commitment to maintaining better glycemic control. For instance, ID007 described that she must control diabetes for her baby. Women shifted their mindset by engaging in positive self-talk, adjusting their thoughts to steer clear of potential risks from diabetes during pregnancy. For example, ID009 expressed that people with T2DM must take their disease seriously. Gaining control over the disease will lead to a healthier body in the future.

In the health care system domain, one support factor was health literacy about insulin dose adjustments and optimal blood sugar levels. The women reported that they tried to adjust the insulin dosage, such as by increasing it by two units if they consumed more food than their usual diet. They also specified their target blood sugar level ranges, indicating that their blood sugar should not exceed 90 mg/dL before meals and 140 mg/dL after meals.

Theme 3 Challenges at interpersonal level for managing diabetes

A subtheme identified within Thai sociocultural context was the influence of the family food environment, which often posed challenges for pregnant women. Living in extended family households with parents, siblings, and other relatives is common, and this cultural norm frequently led to regular gatherings focused on food, such as grilled meat, shabu (a hotpot dish with sliced meat and vegetables), or restaurant visits, typically held weekly or bi-weekly. For instance, ID009, who struggled with blood sugar control, reported that she could not stop eating snacks, which led to her weight reaching 100 kilograms.

Theme 4 Support factors at the interpersonal level for diabetes management

Four subthemes were identified; each subtheme represents a distinct domain of influence including behavioral, physical and built environment, sociocultural environment, and health care system. Within the behavioral domain, family members, such as spouses, parents, and children, supported the women in modifying their eating habits. Many women had meals together with their families; the families attempted to adjust their own meals to match the doctor-recommended foods suggested for the participants. ID014 shared that her husband and children avoid buying soft drinks, desserts, and fruits to accommodate her dietary needs. With this encouragement and support, the women felt less stressed. The women also retained strong food preferences for dishes from their family's regions of origin, incorporating these preferences into their households. For example, ID011 reported that the whole family came from Isan (the northeastern region of Thailand) so they made Isan dishes such as om curry, steam dishes, and jaew (sauce).

The physical and built environment domain included settings constructed or modified through human activity, such as schools and workplaces. Women noted that their workplace environments supported diabetes care in various ways, such as offering flexibility with leave days and providing benefits like cooked rice for employees, annual health checkups, and a private room for blood glucose monitoring. As ID013 shared that there was a room at the office where she could take the blood test.

In the sociocultural environment domain, encompassing social networks and family or peer norms, women emphasized that social interactions and support networks were essential. Physical and emotional support, along with experience-sharing from colleagues, peers, and social networks, proved especially valuable. For instance, Thai women received both types of support from colleagues and peers. One woman shared how a colleague regularly checked in with her, provided mental support, and brought her various foods. Another example, ID009 expressed that her friend who was pregnant and gave the participant some unused blood test kits. In addition, the women shared experiences with other

expectant mothers through social networks like online forums. Many looked up health information on the internet and posted questions on discussion boards to connect with other mothers. ID011 described her approach, explaining that she read through various comments. She found one question from an expectant mother who inquired about the maximum acceptable blood sugar level after an insulin injection. The participant tried to keep her blood sugar within this recommended range.

In the health care system domain, support factors included the guidance and support provided by healthcare providers in medical decision-making and dietary education. For example, dieticians offered recommendations using handbooks or charts detailing dietary allocations. The dietary guidelines provided to the pregnant women were divided into two stages: the initial phase (0 – 6 months) and the later phase (6 months until birth). During this time, women were encouraged to carefully monitor their diet by limiting desserts and serving themselves controlled portions of rice, vegetables, and fruits at each meal. ID007 explained that she was advised to have three main meals a day, supplemented with milk in between. She was also instructed to check her carbohydrate content on nutrition labels to manage her intake. For the third trimester, she could take a little bit more calories. Advice from healthcare providers helped alleviate concerns. After consultations with doctors and dieticians, many women felt less anxious about their condition. For example, ID007 expressed that doctor eased her worries by telling her that insulin injection does not have affect the child.

Theme 5 Challenges at the societal level in accessing healthcare

A key subtheme within health care system domain was the complexity surrounding health insurance coverage. Women often encountered challenges related to coverage limitations. Those with the Civil Servant Medical Benefit Scheme (CSMBS), a direct reimbursement plan, still needed to pay for certain medical equipment and doctor's fees. Many women were uncertain about the differences between the 30-baht universal coverage scheme and their existing social security insurance, questioning whether they could hold both types of coverage simultaneously. ID015, for example, wondered if she could still access the 30-baht scheme despite her social security coverage at a different hospital and whether this coverage could be transferred to another facility. In another instance, ID005 explained that she was registered under the 30-baht scheme in one province but planned to give birth in another, where her current insurance wouldn't be valid, leaving her responsible for covering childbirth expenses.

Women expressed concern over out-of-pocket costs for essential diabetes supplies, such as test strips, alcohol swabs, syringes, and lancets, which are costly. For example, ID009 expressed that she had to purchase the test strips out of her own pocket, which she found problematic.

Theme 6 Support factors at the societal level for healthcare access

A subtheme in the health care system domain highlighted the hospital's role in supporting diabetes management. As per hospital policy, glucometers were provided to allow women to monitor their blood glucose at home. Healthcare facilities and referral systems played a significant role in diabetes care. For instance, ID005, who intended to give birth at a different hospital, explained that she was advised to notify the healthcare providers if she planned to deliver elsewhere. They would then issue the necessary referral document and provide her with the Maternal and Child Health Book. Interdisciplinary care was also crucial for managing diabetes and preventing pregnancy complications. Pregnant women collaborated with various specialists, including internists from medical schools, nurses, endocrinologists, gynecologists, ophthalmologists, and podiatrists. They underwent screenings for diabetes-related complications. For instance, ID009 shared that the doctor examined all parts of her body, including eyes and feet. Women were also prescribed calcium supplements, folic acid, and thrombolytic medications to prevent miscarriage, as ID013 noted that diabetes comes with many risks.

Member Checking on Qualitative Findings

After translating themes and subthemes from the 12 interviews into Thai, we reached out to one participant who had recently given birth, as her pregnancy experiences would likely be fresh in her memory. The first author arranged a meeting with this participant to explain the study's objectives and review the Thai version of **Figure 2**, which depicts the NIMHD domains and levels of influence corresponding to the qualitative subthemes. The participant provided feedback, expressing that the description resonated with her experience. She noted that managing diabetes for the sake of the baby is a personal motivation that guides a mother's decisions.

Mixed-Methods Findings

To facilitate cross-case comparison, we divided participants into two groups: Optimal health outcome ($n = 3$) and suboptimal health outcome ($n = 9$). According to the NIMHD framework (Alvidrez et al., 2019), we integrated the individual-level subthemes with maternal health outcomes. This is because the framework itself assumes that maternal health outcomes are influenced by factors at the individual level (Alvidrez et al., 2019) (**Table 3**).

Each individual-level subtheme revealed both converging and diverging results from comparison and integration. In the biological domain, we found that women in both groups experienced hypoglycemia; however, little information was known about the frequency of hypoglycemia episodes in the two groups. Regarding the behavioral domain, both groups faced challenges in managing diabetes, including diet control and a sedentary lifestyle. For example, women with optimal health mentioned their intention to *"reduce the amount" (ID009)*, while women with suboptimal health described their cravings and awareness that not controlling their diet *"led to high blood sugar" (ID003)*. In the health care system domain, we observed a divergent result in the group with optimal health. Although this group achieved good glycemic control (HbA1C less than 6.5%) and optimal GWG, they still lacked health literacy on proper aseptic technique for insulin injection, which is considered a barrier. This was evident in their practices, such as only replacing the needle every three days. This underscores the necessity for clearer guidance and education on correct insulin injection techniques.

Furthermore, as a support factor, both groups expressed the importance of diabetes management. However, the group with suboptimal health reported that they needed to manage diabetes for their babies to prevent *"risky consequences"* (ID007). In contrast, the group with optimal health focused on their bodies, believing they *"may become healthier in the future"* (ID009). Finally, regarding the support factor of the health care system domain, the group with optimal health

participants knew the normal range of blood sugar levels. In the group with suboptimal health, women described how they adjusted the dose of insulin depending on the amount of food they consumed. This may imply that women in this group adjust their doses frequently, possibly due to difficulty in controlling their diet. This could be an area for further investigation, particularly regarding dose adjustments and the fluctuation of blood sugar levels during pregnancy.

Table 3 Joint display to compare and integrate findings (*N* = 12)

Domain of influence	Individual level challenges and support factors	Comparison Optimal health (*n* = 3)	Suboptimal health (*n* = 9)	Integration (Convergence/Divergence)
Biological	**Episodes of hypoglycemia during pregnancy (-)**	"Some days. But mostly, I would feel light-headed when the blood sugar level is around 78 or 86. No, I don't have heart palpitations. But I do get shaky hands sometimes. (ID013)"	"So, I woke up feeling dizzy. I tested my blood sugar level then, and it was over 60. I felt dizzy. (ID006)"	**Convergence:** Women had suboptimal health outcome and experienced the symptom of hypoglycemic. **Divergence:** Although women had optimal health outcome, they also reported experiencing episodes of hypoglycemia during pregnancy. **Summary:** We found that in both groups, women experienced hypoglycemia. However, little information was known about the frequency of hypoglycemia episodes in the two groups.
Behavioral	**Challenges in diabetes management during pregnancy (-)**	"I couldn't stop having white rice, but I tried to reduce the amount…It still didn't sink in… But I ate plenty of rice: one plate, two plates, even three plates of rice at a time. I ate it without restraint (ID009)" "It's only been 12 weeks. So, I walk lightly. I dare not walk a lot. I'm afraid to walk quickly. I do things lightly. I didn't go anywhere (ID014)"	"It's like when I'm pregnant, I feel tired; so I want food. Especially during the first month, the first two months, it was like I only wanted to have fruits, fruit juice, and ice cream. This led to high blood sugar (ID003)" "I seldom exercise. At most, I might take a short walk after a meal. When I work, I would be sedentary for a long time. It's not quite feeling tired. What's it called? Like, if I were to stand for a long time, I would feel fatigued and weighed down. (ID006)"	**Convergence:** Women had suboptimal health outcome and expressed facing difficulties in controlling diet and had sedentary lifestyle. **Divergence:** Women who experienced optimal health outcomes expressed challenges in managing their diet and having a physically active lifestyle. **Summary:** Regarding the behavioral domain, both groups faced challenges in managing diabetes, including diet control and a sedentary lifestyle. For example, women with optimal health mentioned their intention to *"reduce the amount" (ID009)*, while women with suboptimal health described their cravings and awareness that not controlling their diet *"led to high blood sugar" (ID003)*.
	Positive motivation and mindset shift for diabetes management (+)	Diabetes patients must examine this seriously and look after themselves in earnest. This will make things better for us. Our bodies may become healthier in the future (ID009)"	"I had to force myself to do it. But I must do it for my baby. I must do it… It's about the mindset as well. I had to change my thoughts. I had to be able to do what the doctor recommended. Because if I couldn't do it, there would be risky consequences (ID007)"	**Convergence:** Women with optimal health, as they reported using positive self-talk to reinforce the benefits of taking care of themselves during pregnancy. **Divergence:** Women with suboptimal health outcomes reported changing their mindset and expressed a desire to manage their diabetes during pregnancy to benefit their baby's health. This indicates that concern for their baby's well-being served as a motivator to adopt better diabetes management practices. **Summary:** Both groups expressed the importance of diabetes management. However, the group with suboptimal health reported that they needed to manage diabetes for their babies to prevent *"risky consequences" (ID007)*. In contrast, the group with optimal health focused on their bodies, believing they *"may become healthier in the future" (ID009)*.

Table 3 (Cont.)

Health care system	Lack of health literacy on proper aseptic technique for insulin injection (-)	"The needle for the insulin injection can be replaced every three days. If I don't replace it, then it would be painful because the needle would become dull. Replacing the needle helps to reduce the pain. I'm the only person using these supplies anyway... I don't need to clean the needle because there's a silicone scabbard. The doctor didn't tell me to clean the needle. But before injection, I would use the alcohol swab to wipe the skin at the injection site. (ID013)"	NR	**Divergence:** Only women with optimal health outcomes reported a lack of health literacy regarding insulin injection. This was evident in their understanding and practices, such as one woman stating she replaces the needle every three days to avoid pain from a dull needle, believes cleaning the needle isn't necessary due to the silicone scabbard, and uses an alcohol swab to clean the injection site, despite not receiving specific instructions from her doctor. **Summary:** This highlights the need for clearer guidance and education on proper insulin injection techniques.
	Health literacy on insulin dose adjustments and optimal blood sugar level (+)	"Before a meal, the blood sugar level should not exceed 90. It should not exceed 95 for lunch and dinner. But after a meal, it should not exceed 140 (ID013)"	"If I felt that I ate too much, I would increase the insulin dosage. I could increase the dosage myself by around two units. Not more than that. Yes. When I ate very little, the blood sugar level fell (ID015)"	**Convergence:** Women with optimal health reported having knowledge about normal blood sugar levels during pregnancy. **Divergence:** Women with suboptimal health shared their understanding of how to adjust their insulin doses based on their current blood sugar levels. **Summary:** The optimal health group knew the normal blood sugar range. Those with suboptimal health adjusted their insulin based on food intake.

Notes: (-) is challenge; (+) is support factor

Furthermore, as a support factor, both groups expressed the importance of diabetes management. However, the group with suboptimal health reported that they needed to manage diabetes for their babies to prevent *"risky consequences"* (ID007). In contrast, the group with optimal health focused on their bodies, believing they *"may become healthier in the future"* (ID009). Finally, regarding the support factor of the health care system domain, the group with optimal health participants knew the normal range of blood sugar levels. In the group with suboptimal health, women described how they adjusted the dose of insulin depending on the amount of food they consumed. This may imply that women in this group adjust their doses frequently, possibly due to difficulty in controlling their diet. This could be an area for further investigation, particularly regarding dose adjustments and the fluctuation of blood sugar levels during pregnancy.

Discussion

Principal Findings
The study is based on the NIMHD framework (Alvidrez et al., 2019) to identify the challenges and support factors of managing T2DM in pregnant women living in Bangkok, Thailand. Qualitative findings indicated both similarities and differences with the quantitative results concerning diabetes management among pregnant women.

Challenges and support factors at individual level
Pregnant women with T2DM have faced several challenges in managing their condition. One key finding was the difficulty of controlling diet because, for Thai people, food was seen as an vital part of lives. This perspective created a challenge to following healthy and balanced dietary guidelines during pregnancy, aligning with findings from previous studies

(Dennison et al., 2019; Lawrence et al., 2021). Often, pregnant women craved sweet foods, such as fruits and ice cream, as well as starchy foods like rice. Cravings for sweets were linked to increased intake of sucrose and overall fat, while cravings for starchy foods were associated with higher carbohydrate consumption and an elevated glycemic load (Farland et al., 2015). Future studies could benefit from exploring relationships between pregnancy cravings and dietary control, as well as their impact on pregnancy outcomes.

Pregnant women with T2DM preferred low-impact walks as a form of light physical activity. Regular walking has been shown to reduce blood sugar levels (Hayashi et al., 2018). A study examining an exercise program for pregnant women with T2DM found that 30 minutes of moderate-intensity stationary cycling over 10 weeks effectively reduced average blood glucose levels compared to those receiving standard prenatal care (E-Mekawy et al., 2016). Further research is needed to examine which specific exercises and its duration could be most effective for pregnant women with T2DM.

Interestingly, one divergent finding showed that only pregnant women with good health outcomes (optimal glycemic control and gestational weight gain) were not adhering to proper aseptic techniques for insulin injection. Prior research has indicated that proper insulin pen selection and education help improve insulin injection techniques, enhance patient satisfaction with diabetes management, and result in better glycemic control (Gorska-Ciebiada et al., 2020). This underscores potential benefits of providing support for women during pregnancy.

Pregnant women reported challenges in coordinating blood sugar testing and insulin injections with their mealtimes, a difficulty also observed in a study on insulin-meal mismatches among hospitalized patients with T2DM (Lim et al., 2020). Coordinated insulin-meal administration was

associated with reduced glycemic fluctuations in individuals hospitalized with T2DM (Lim et al., 2020). This emphasizes the need to customize diabetes management tasks to align with women's daily routines. One study suggested that using patches instead of pens and syringes may be beneficial for adults with T1DM and T2DM (Peyrot et al., 2018). The patch is user-friendly and offers a discreet method for delivering insulin, which could improve patient adherence to mealtime insulin regimens for those currently using injection devices (Peyrot et al., 2018). Our suggestion is that health care providers may consider using patches for pregnant women who struggle to coordinate their mealtimes with insulin injections.

At the individual-level support factors, pregnant women's motivations to manage their diabetes for the sake of their baby, along with positive self-talk, influenced their behavior changes. Women with suboptimal health outcomes noted that one of their motivations for improving diabetes control during pregnancy was the health of their baby. Consistent with our findings, a study by Youngwanichsetha and Phumdoung (2017) revealed that Thai women understood the importance of better controlling their T2DM to benefit their baby's health. Since understanding the motivations that drive pregnant women to better manage their diabetes is essential, future studies could explore the maternal-fetal relationship and how this motivation can be leveraged in diabetes management. Most pregnant women practiced positive self-talk during their pregnancy. These findings align with a previous study showing that individuals with T2DM often employ self-enhancement techniques, fostering positive thoughts as part of their diabetes management strategy (Swarna Nantha et al., 2021). The positive thoughts boosted women's self-esteem and overall well-being (Swarna Nantha et al., 2021). The findings highlight the significance of maintaining a positive mindset in managing diabetes during pregnancy. Furthermore, improving health literacy regarding insulin dose adjustments is crucial for maintaining optimal blood sugar levels. Personalized insulin adjustments can be implemented using a titration algorithm, such as increasing the dose by 2 units every three days, to achieve glycemic targets while minimizing the risk of hypoglycemia (American Diabetes Association Professional Practice Committee, 2022). This information is especially important for women who need to adjust their insulin doses, particularly during pregnancy when hormone and blood sugar levels are subject to fluctuations (American Diabetes Association Professional Practice Committee, 2022).

Our study's mixed-method findings had significant insights. Regardless of health outcomes, women faced common challenges throughout their pregnancy journey. Effectively managing diabetes during pregnancy necessitates dynamic, patient-centered care, aligning with previous research emphasizing the importance of individualized care to enhance maternal outcomes for women with diabetes (Sushko et al., 2023). Future studies may design patient-centered interventions that provide ongoing care for pregnant women with diabetes.

Challenges and support factors at interpersonal level
At the interpersonal level, women noted challenges in managing diabetes due to their family's food environment. Factors such as the presence of snacks in the household and frequent family gatherings centered around foods were identified as challenges. In Thai culture, there is a strong emphasis on kinship and family relationships, which can complicate dietary adherence for those managing diabetes (Lundberg & Thrakul, 2013). Consistent with our findings, another Thai study revealed that family members can play a crucial role in an individual's ability to self-manage diabetes, particularly by providing support in planning healthy meals (Lundberg & Thrakul, 2013). For pregnant women living in extended families, home visits and modifications to the household food environment may be essential to support effective diabetes management during pregnancy.

Support factors at the interpersonal level were identified across the behavioral, physical and built environment, sociocultural environment, and health care system domains. In the behavioral domain, pregnant women with T2DM reported that their family members played a crucial role in modifying their eating behaviors and reducing stress. These findings are consistent with a systematic review emphasizing the significance of family support as a vital element in fostering healthy dietary habits (Pamungkas et al., 2017). Educating family members can empower them to support pregnant women in making healthy dietary choices and managing stress, both of which may contribute to improved glycemic control (Pamungkas et al., 2017).

Workplaces can significantly contribute to diabetes care during pregnancy by implementing measures such as flexible leave policies, conducting annual health checkups, and providing designated areas for women to monitor their blood glucose levels. These accommodations support pregnant women with T2DM in managing their daily responsibilities while also allowing them to fulfill their work obligations effectively (Park et al., 2022). Employer-based interventions, implemented in partnership with healthcare systems, could be particularly effective in enhancing maternal health.

Physical and emotional support from colleagues and peers can significantly aid in diabetes management. Peer support programs, designed to complement standard care, have been shown to enhance behaviors related to diabetes management (Aziz et al., 2018). Women sought health information from websites and actively posted their questions on discussion forums with other mothers. This aligns with a meta-analysis of 39 previous studies that identified a prevalent trend of information exchange related to pregnancy among mothers on online platforms (Xie et al., 2021). This trend is widespread and continues to grow, emphasizing the necessity for health care providers to acknowledge the potential of social networks and online platforms in supporting maternal health.

Challenges and support factors at societal level
A societal-level barrier identified in our study pertains to health care access, specifically the complexities surrounding Thai health insurance and the costs associated with medical supplies. Women often encounter difficulties navigating the intricacies of health insurance coverage, which is structured into three primary schemes based on an individual's employment status (Sumriddetchkajorn et al., 2019). The following schemes are in place: (i) the medical benefits scheme for civil servants managed by the Ministry of Finance; (ii) the social security scheme overseen by the Ministry of Labor; and (iii) the universal coverage scheme administered

by the Ministry of Public Health. (Sumriddetchkajorn et al., 2019). Each scheme functions within its unique legal framework, leading to unavoidable differences in access to healthcare services, including medications and medical supplies (Sumriddetchkajorn et al., 2019). Therefore, providing a more comprehensive explanation of the benefits and limitations of each health insurance scheme, along with guidance on the most suitable option for individuals, would be advantageous. Additionally, women reported that medical supplies, such as test strips, are costly, a finding consistent with another Thai study (Sumriddetchkajorn et al., 2019). It implies that medical costs pose a significant obstacle to effective diabetes management (Somanawat et al., 2020). Diabetes is a complex condition that requires continuous management and care (Somanawat et al., 2020). Therefore, improving access to affordable medical supplies could be a crucial strategy for addressing these challenges.

A societal-level support factor identified within the health care system was the provision of free glucometers by hospitals, which empowered women to monitor their blood glucose levels at home, thereby enhancing their ability to manage their condition. This aspect, often overlooked in the literature, emphasizes the significance of practical support in improving diabetes management during pregnancy. Health care system can bolster this support by implementing interdisciplinary approaches. A previous study indicated that an interdisciplinary team can effectively establish and share management goals, continuously improving care for pregnant women with diabetes (Netgrajang, 2019). Our study highlighted the importance of a referral system. To enhance continuity of care, it would be beneficial to provide detailed information about Thailand's patient referral systems, particularly as they relate to women's health insurance schemes (Aumpanseang et al., 2022).

Implications of the Study for Nursing Practice
According to our findings, there are several implications for nursing practice as follows.

First, enhancing support systems: Nurses should recognize the importance of a robust support system for pregnant women with diabetes. They can facilitate connections among family members, co-workers, and peers to foster understanding and provide emotional and practical support. Incorporating family members into education sessions can empower them to assist women in managing their diabetes effectively.

Second, individualized care plans: Nursing practice should focus on creating individualized care plans that consider the unique challenges faced by pregnant women with diabetes. This includes recognizing the influence of cravings and the household food environment on dietary choices. Nurses should engage in open discussions with patients about their cravings and provide practical strategies for healthier eating.

Third, strengthening health systems: Nurses can advocate for improved health systems that enhance the availability of medical supplies and resources for managing diabetes during pregnancy. They should work towards implementing efficient referral systems to ensure continuity of care, particularly for those requiring specialized services.

Fourth, interdisciplinary collaboration: Promoting collaboration among interdisciplinary teams—including obstetricians, endocrinologists, and dietitians—is crucial. Nurses can lead efforts to establish communication channels among team members, ensuring that all healthcare providers are informed and aligned in their approach to managing diabetes during pregnancy.

Strengths and Limitations
Our study presents several strengths, notably a mixed-methods approach that integrates various aspects of women's experiences by collecting both subjective (interview) and objective (HbA1C levels and gestational weight gain) data. To enhance data accuracy and ensure confirmability, we employed a rigorous qualitative methodology involving three independent coders for data analysis, and we verified our findings by consulting a participant to confirm that our interpretations reflected her perspective accurately. Our quantitative approach was equally thorough, with a research assistant trained specifically to extract and review maternal health outcomes.

However, our study also has limitations. First, since we recruited pregnant women exclusively from one hospital in Bangkok, Thailand, our findings may have limited generalizability to other regions in the country with different sociocultural contexts. We compared our results with existing literature to enhance the transferability of our findings. Second, most participants were multigravida with a range of gestational ages, which may not fully capture the experiences of primigravida or the changes occurring across various trimesters. Future research could investigate these differences to provide a more complete perspective. Lastly, in this mixed-methods study with a qualitative focus, we maintained the same sample size for both the quantitative and qualitative components to facilitate data integration for each participant (Lincoln & Guba, 1985). We recognize that the small sample size in the "optimal" group ($n = 3$), compared to the "suboptimal" group ($n = 9$), may reduce the effectiveness of cross-case comparisons and potentially impact the reliability of our findings. This limitation may have affected the rigor of our quantitative results. Future studies should aim to recruit a larger sample to improve the robustness and generalizability of the mixed-methods findings and increase the sample size for both groups. Quantitative analysis relied solely on descriptive methods, which may restrict the strength of conclusions regarding the relationships between identified challenges and health outcomes. Future research could address this by increasing the sample size and employing more advanced analyses (e.g., regression or correlation) to strengthen the findings.

Conclusion

Using the NIMHD framework as a guide, this study identified multiple levels of challenges and supportive factors involved in managing T2DM among pregnant women in Thailand. Our findings highlight the key obstacles and possible strategies for effective diabetes management within this group. Future research should focus on creating and assessing the effectiveness of interventions aimed at individuals, family members, peers, colleagues, workplaces, and health care systems. This proposed model—a dynamic, comprehensive, patient-centered approach—offers a valuable foundation for

developing supportive measures to help pregnant women with T2DM manage their condition and achieve positive health outcomes during pregnancy.

Declaration of Conflicting Interest
No conflicts of interest to declare.

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Authors' Contributions
RP contributed to the study's conception and design, data acquisition, data analysis, wrote the first draft of the manuscript. RP, CHT, and MB were involved in data analysis. CS, AP, EH, YC, and MB provided project supervision. All authors revised the final draft and gave final approval of the version to be published.

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Data Availability
The datasets generated during and analyzed for the current study results are available from the first and corresponding authors upon reasonable request.

Declaration of Use of AI in Scientific Writing
There is nothing to declare.

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