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Lifestyle Modifications May Improve Glycemic Control in Pregnant Women

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Abstracts

Over 23% of adults 18 years and older are considered physically inactive or insufficiently active (World Health Organization [WHO] [1]. This is the leading risk factor for mortality worldwide and a key risk factor for disease and disability, including obesity, cardiovascular disease (CVD), hypertension, diabetes mellitus (DM), and gestational diabetes mellitus (GDM) [1-5]. GDM prevalence is up to 25% pregnancies globally and close to 10% in the US [6, 7]. GDM can cause physiological and psychological problems in pregnant women [3, 6]. Studies have shown various interventions such as lifestyle modification of diet and exercise have been found favorable in controlling GDM and preventing pregnancy related adverse outcomes. Thus, clinicians are charged with counseling and promoting lifestyle modification in all pregnant women during patient encounters.

Introduction

Over 23% of adults 18 years and older are considered physically inactive or insufficiently active [1]. The WHO has identified physical inactivity as a leading risk factor for mortality worldwide and a key risk factor for disease and disability, such as obesity, cardiovascular disease, hypertension, diabetes mellitus (DM), and gestational diabetes mellitus (GDM) [1-5].

GDM is defined as a carbohydrate and glucose intolerance of any degree with varying severity, resulting in hyperglycemia that is first detected and diagnosed during pregnancy, usually after 24 weeks of gestation and is not overtly type 1 DM (T1DM) or type 2 DM (T2DM) [8-13]. Due to varying diagnostic criteria, risk factors, and demographic characteristics, the prevalence of GDM is difficult to determine, so its true significance is unknown [3, 7]. However, some studies have found that GDM affects up to 25% of pregnancies globally and as high as 9.2% in the United Sates [6, 7].

Problem

In the United States, GDM is more prevalent in non-white ethnicities, such as African-American, Hispanic, Native Hawaiian, Pacific Islander, and Asian, with Pacific Islander and Asian women having the greatest risk [5, 14-16]. Modifiable and non-modifiable risk factors include advanced maternal age greater than 35 years old, height of less than 1.5 m or 5 feet, smoking, and family history of diabetes, history of GDM, history of recurrent miscarriages, obesity, and polycystic ovary syndrome [2, 3, 5]. Obstetric history, such as fetal or neonatal death, macrosomia, multi-parity, offspring malformation, preeclampsia, pregnancy induced hypertension, polyhydramnios, twin pregnancy and lifestyle choices, e.g. poor diet, physical inactivity, and/or sedentary lifestyle are also significant for GDM risks [2, 3, 5].

Studies have shown that GDM may cause psychological problems of anxiety and emotionally distress, resulting in a negative pregnancy experience and poorer health perceptions [6, 17]. Many pregnant women expressed feelings of shock, fear, and denial when initially diagnosed with GDM, and most were worried, frightened, or concerned regarding the possible fetal and neonatal adverse effects [6, 17, 18].

Physiological problems associated with GDM include pregnancy and birth complications, such as disorders of pregnancy induced hypertension, preeclampsia or eclampsia, macrosomia, shoulder dystocia, non-elective cesarean section, birth injuries of bone fracture or nerve palsy, fetal hyperinsulinemia, or neonatal intensive care unit (NICU) admission [3, 6, 19]. Long-term maternal complications include an increased risk of developing T2DM, cardiovascular disease, and metabolic syndrome [3]. There is little research on long-term complications of GDM in children, however, newborns and offspring born from women with a history of GDM have an increased risk of developing metabolic disorders, include metabolic syndrome, obesity, prediabetes, and T2DM [3, 9].

Primary prevention for GDM targets adult women in the preconception phase and focuses on healthy lifestyles of proper diet, exercise, and/or weight loss, and preventing pregnancy risk factors [20]. Secondary prevention targets women who are at risk with GDM during the early antenatal phase and focuses on early screening, early diagnosis, pharmacological, non-pharmacological treatment, and lifestyle modifications [20]. Tertiary prevention targets women with complicated GDM and their newborns and offspring at the antenatal, inter-conception life phase and focuses on the management of GDM complications to minimize their impact on maternal/neonatal health [20].

Current evidenced-based practice guidelines recommend aggressive treatment of GDM, with the goal of improving glycemic control to prevent or decrease adverse maternal and fetal outcomes [19, 21, 22]. Standard guidelines in glycemic control in pregnant women with GDM include glucose monitoring and lifestyle modifications, i.e. nutritional therapy and moderate-intensity exercises [4, 19, 21, 22]. Pharmacological treatment, such as oral medications and/or insulin injection, is utilized if glycemic control cannot be accomplished with lifestyle modifications alone [4, 19, 21, 22].

Literature Review

Afaghi et al. [10] hypothesized that a low-glycemic-index and low-glycemic-load diet with fiber (e.g. wheat bran), compared to a regular diet, would show effective postprandial blood glucose (PBG) control

in women diagnosed with GDM, potentially reducing insulin requirement in this population. This study was a randomized controlled trial, with a sample size of 31 pregnant women between 20-40 years of age who were diagnosed with GDM, were referred to the endocrine clinic, have a pre-pregnancy body mass index (BMI) of 18.5-29, and were between 24-28 weeks of gestational age [10]. Participants were randomly allocated between two diet groups: Fiber group (n=18), which received an LGI/LGL plus 15 grams of wheat bran, and the Without Fiber group (n=13) [10]. Results also showed that 61.1% of the Fiber group achieved glycemic control compared to 23.1% of the Without Fiber group [10]. The study concluded that an LGI/LGL diet can significantly reduce blood glucose levels. An LGI/LGL diet with added fiber had significant effects on PBG in women diagnosed with GDM [10]. Based on these findings, an LGI/LGL diet consumed with fiber could be utilized to improve glycemic control in pregnant women diagnosed with GDM [10].

Kizirian et al. [23] hypothesized that LGI/LGL meals would produce lower glucose levels during the daytime and less glycemic variability compared to high-glycemic-load (HGL) meals. The study was a within-subject randomized crossover trial, with a sample size of 17 pregnant women who met at least one inclusion criteria: Pre-pregnancy BMI ≥ 30, over 35 years of age, previous history of glucose intolerance or GDM, history of macrosomia birth (> 4,000 g), family history of first-degree relative with T2DM, history of polycystic ovarian syndrome, from an ethnic group with increased prevalence of GDM, e.g. Aboriginal, Middle Eastern, Polynesian, South East Asian, South Asian, Torres Strait Islander [23]. Participants were recruited through an antenatal clinic at the Royal Alfred Hospital in Camperdown, Australia [23]. Dietary interventions were implemented for four days, but data from days two and three were excluded from analysis [23]. All the required foods for 1 day of HGL meals and 1 day of LGI/LGL meals were provided to each participant, and continuous glucose monitors (CGMs) were utilized to electronically measure each participant's subcutaneous (SC) interstitial glucose levels every 5 minutes [23]. This study concluded that, compared to a traditional diet, an LGI/LGL diet is significantly more effective in improving glycemic control, providing less glycemic variability, and increasing time within the target glucose range [23].

Asemi et al. [24] investigated the effects of the Dietary Approach to Stop Hypertension (DASH) diet on insulin resistance. FBG, serum insulin levels, and Homeostasis Model of Assessment – Insulin Resistance [HOMA-IR]), serum high-sensitivity C-reactive protein (hs-CRP), and biomarkers of oxidative stress (e.g. total antioxidant capacity [TAC] and total glutathione [GSH]) can have effects on pregnant women diagnosed with GDM. The study was a randomized, two-arm parallel clinical trial, with a sample size of 32 pregnant women between 18-49 years of age and diagnosed with GDM [24]. Participants were randomly allocated to the DASH diet group (n=16) and the Control diet group (n=16) after stratification for gestational age and BMI [24]. Dietary interventions were implemented for four weeks, after which biochemical markers were measured at a reference laboratory in Kashan, Iran [24]. Results showed that FBG, serum insulin levels, and HOMA-IR score in the DASH diet group were decreased compared to the Control diet group [24]. The study concluded that the DASH diet had beneficial effects on the HOMA-IR score, serum insulin levels, FPG, and biomarkers of oxidative stress, which could positively impact the "metabolic profiles of pregnant women diagnosed with GDM" [24]. Based on these findings, the DASH diet could be utilized to achieve glycemic control in pregnant women diagnosed with GDM [24].

Youngwanichsetha et al. [4] investigated the effects of yoga exercise and mindful eating on blood glucose levels in pregnant Thai women diagnosed with GDM. The study was a randomized controlled trial, with a sample size of 180 participants who were pregnant Thai women diagnosed with GDM, had a FBG < 105 mg/dl, had a PBG < 120 mg/dL, were not receiving insulin for glycemic control, and had no serious complications of preterm labor, preeclampsia, gestational hypertension, and/or other serious medical problems [4]. Participants were randomly assigned to a Control group (n=90), which received standard diabetes care, and the Intervention group (n=90), which received standard diabetes care in conjunction with yoga exercises and mindful eating [4]. Interventions were implemented for eight weeks, and the primary outcomes of interest were FBG, PBG, and hemoglobin A1c (HbA1c) [4]. Results showed that the Intervention group had significantly lower post-intervention FBG, PBG, and HbA1C compared to the Control group, 83.39 vs. 85.85, 105.67 vs. 112.36, and 5.23% vs. 5.68%, respectively. The study concluded that yoga exercise combined with mindful eating had beneficial effects on health outcomes in pregnant Thai women diagnosed with GDM [4].

Halse et al. [25] examined the effects on a supervised, home-based cycling exercise program on daily FBG, PBG, insulin sensitivity, glucose tolerance, and HbA1C when immediately initiated at the diagnosis of GDM. The study was a randomized controlled trial, with a sample size of 40 women with single pregnancy, between 26-30 weeks of gestational age, were non-smokers, had a normal 18-week fetal anatomy scan, had a BMI ≤ 45, were not recently involved in a structured workout program, and were medically cleared to participate in exercise [25]. Participants were randomly assigned to conventional management group with exercise (EX, n=20) and conventional management only group (CON, n=20). Interventions were implemented in the EX and CON group until participants reached 34 weeks of gestational age [25]. Results showed that acute glucose response in the EX group decreased from 6.3mM to 4.9mM [25]. Mean CBG remained within the target FBG and PBG ranges, and overall mean PBG levels were significantly lower in the EX group compared to the CON group [25]. Blood glucose response to post-intervention oral glucose tolerance tests (OGTT) and insulin response did not differ significantly between the EX group and CON group [25]. There were no differences between the EX and CON group in HbA1c [25]. Although there were no statistically significant findings related to glucose tolerance and HbA1c, the study concluded that the implemented exercise intervention improved daily PBG control [25]. In addition, mean compliance rate to the exercise intervention was 96% with minimal missed sessions throughout the study [25]. Based on these findings, implementing a supervised, home-based cycling exercise program may help improve glycemic control in pregnant women diagnosed with diet-controlled GDM [25].

Discussion and Application

The Afaghi et al. [10], Kizirian et al. [23], and Asemi et al. [24] studies have all explored the effects of dietary interventions on blood glucose levels, insulin resistance, and/or glycemic control in pregnant women at risk or diagnosed with GDM. The Afaghi et al. [10] and Kizirian et al. [23] studies utilized an LGI/LGL and LGI/LGL diet consumed with added fiber, respectively, while the Asemi et al. [24] study utilized the DASH diet. All three studies concluded that their implemented dietary intervention had beneficial effects on glycemic control in pregnant women diagnosed with GDM, which was initially surprising especially regarding the DASH diet [10, 23, 24]. However, on further analysis, the LGI/LGL diet with added fiber utilized by Kizirian et al. [23] was similar in nutrient composition with the DASH diet utilized by Asemi et al. [24]. Both diets were low in simple sugars and high in fruits and vegetables, which previous studies shown to have positive effects on insulin resistance [24]. In addition, both diets had higher fiber contents compared to the control diets in their respective studies; the LGI/LGL diet in the [23] study had an additional 15 grams of fiber and the DASH diet in the [24] study had a fiber content that was 1.5-2 times higher compared to the control group. Based on this analysis, both an LGI/LGL diet and an LGI/LGL diet with added fiber (like the DASH diet), could be utilized to improve glycemic control in pregnant women diagnosed with GDM.

The study by Youngwanichsetha et al. [4] also explored the effects of dietary interventions on blood glucose levels in pregnant women diagnosed with GDM. This study utilized mindful eating, which included setting a glycemic target, considering portion sizes, decreasing or eliminating diabetic foods, and eating slowly (over 30-45 minutes) [4]. Similarly to the Afaghi et al. [10], Kizirian et al. [23], and Asemi et al. [24] studies, it also incorporated an LGI/LGL diet as part of their dietary intervention [4]. However, unlike these previous studies, the study by Youngwanichsetha et al. [4] also explored the effects of exercise interventions on blood glucose levels in pregnant women diagnosed with GDM, specifically yoga. The study concluded that combining mindfulness eating and yoga exercises optimized glycemic control in pregnant women diagnosed with GDM [4]. Since there is limited research on the effectiveness of these specific interventions on the treatment of GDM in pregnant women, there may be some hesitation to implement them in this population [4]. However, on further analysis, mindful eating was developed from the foundation of nutritional therapy and yoga is a type of moderate-intensity exercise; nutritional therapy and moderate-intensity exercises are examples of lifestyle modifications, which are considered current evidenced-based practice guidelines on the treatment of pregnant women diagnosed with GDM [4, 16, 19, 21]. Based on this analysis, combining mindfulness eating and yoga exercise could be utilized to improve glycemic control in pregnant women diagnosed with GDM.

The Halse et al. [25] also explored the effects of exercise interventions on the blood glucose profile in pregnant women diagnosed with GDM, specifically utilizing a supervised, home-based exercise program that consisted of interval training combined with continuous-steady state cycling. Similarly to the Youngwanichsetha et al. [4] also concluded that implementing a moderate-intensity exercise can have beneficial effects on glycemic control in pregnant women diagnosed with GDM [25, 26]. However, unlike the Youngwanichsetha et al. [4] study, the Halse et al. [25] study also explored the effects of their supervised, home-based cycling program on exercise motivation and enjoyment. With a 96% compliance rate, the study concluded that their exercise intervention had beneficial effects on improving adherence [25]. However, there are aspects in the study that make it difficult to determine if implementation would be feasible in this population [25]. For example, supervision was conducted by an exercise physiologist (EP) that came to the participants' houses three times a week and actively tailored the exercises to the individual participants [25]. Based on this analysis, a moderate-intensity exercise, such as cycling, can be utilized to improve glycemic control in pregnant women diagnosed with GDM. Clinicians should recommend an exercise program for pregnant women diagnosed with GDM.

Implications

Studies have shown that physically inactive pregnant women are more likely to develop GDM [3, 4]. However, women diagnosed with GDM usually remain physically inactive despite understanding the benefits of an exercise program [25]. In addition, 60% of pregnant women diagnosed with GDM are unable to achieve their recommended glycemic goal despite receiving education and nutritional counseling regarding their dietary choices [4]. Clinical process can optimize a patient's likelihood of adopting new behaviors to decrease GDM-associated adverse maternal and neonatal outcomes [27].

Exercise

Women commonly reported that inadequate support and supervision played an immense role on adherence with their treatment plan, especially with exercise [17, 28]. When developing and implementing exercise regimens, clinicians can provide methods of continuous support and supervision throughout the pregnancy [25]. This can be accomplished by recommending group exercise classes, where peer motivation can improve exercise adherence and enjoyment [4, 17, 25, 28].

Diet

Women prefer receiving visual information regarding self-glucose monitoring and healthy dietary habits; they perceive written information overwhelming and inconvenient [29, 30]. Clinicians can utilize the use of a mobile application, such as the Pregnant+ app, which provides easily accessible information on the patient's cellphone [30]. The Pregnant+ app, which studies have found to be useful in the management of GDM, can provide visual, portable information regarding diagnosis, healthy food choices of LGI/LGL foods and/or LGI/LGL foods with added fiber; real-time blood glucose readings can be automatically transferred from the glucometer [4, 10, 23, 24, 30].

Health Care System

GDM is a growing clinical and public health concern and is the most predictive factor for developing T2DM later in life [3, 16, 27, 28]. Over 50% of women with diet-controlled GDM can develop T2DM within 5-10 years following the index pregnancy [3]. GDM is also associated with an increased risk of developing metabolic syndrome and cardiovascular disease [3]. The risk of developing metabolic syndrome is 17.6% in women diagnosed with GDM and 20% in women with previous GDM [3]. Women with GDM have a 70% higher risk of developing cardiovascular disease, compared to women without, and can occur within 11 years following the index pregnancy [3].

With GDM's increasing prevalence and its associated risk of adverse outcomes, there is an increased economic burden on the health care system to provide additional services and resources for this population [31, 32]. In 2007, approximately 180,000 GDM pregnancies that resulted in deliveries were associated with $636 million in increased health care and medical costs; roughly costing $596 million for mothers and $40 million for newborns and offspring [31, 32]. In 2012, the national health care costs associated with GDM and elevated blood glucose levels increased to $1.3 billion [32].

Future Research

All the studies analyzed in this review were conducted outside of the United States. In addition, most of the studies had small sample sizes (the lowest had 17 participants) and were extremely short in duration [4, 10, 23-25]. Future research is indicated to determine if interventions in these studies would produce similar findings and be representative of pregnant women diagnosed with GDM in the United States. Furthermore, there is limited information on the effects of providing visual information as a tool, such as the Pregnant+ app, for pregnant women diagnosed with GDM [29]. Future research is indicated to determine the effectiveness of this intervention on the adherence and outcomes of pregnant women diagnosed with GDM.

Conflict of interest: The authors have declared no conflict of interest.

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