A review of exercise as an intervention for reducing the risk of gestational diabetes between the years 2002-2021

by

Amanda D'Orsi

B.S., Johnson & Wales University, 2016

A REPORT

submitted in partial fulfillment of the requirements for the degree

MASTER OF SCIENCE

Department of Food, Nutrition, Dietetics, and Health
College of Health and Human Sciences

KANSAS STATE UNIVERSITY
Manhattan, Kansas

2021

Approved by:

Major Professor
Mark Haub

Copyright

Abstract

Introduction:

Gestational diabetes is a common maternal complication, affecting 6-9% of pregnant women, that has increased in incidence in recent years coinciding with the increase in Type 2 diabetes. The American College of Obstetrics and Gynecology, the Academy of Nutrition and Dietetics and The Dietary Guidelines for Americans all recommend that pregnant women exercise a minimum of 150 minutes weekly to help promote maternal health and reduce risk of gestational diabetes. Randomized controlled trials have had conflicting results on the efficacy of exercise as an intervention to reduce the risk gestational diabetes. The purpose of this literature review was to evaluate if exercise during pregnancy is an appropriate intervention which could aid in reducing the risk of gestational diabetes.

Method:

A PubMed search of the MeSH terms exercise, and diabetes, gestational was completed. The initial search yielded 809 results. Next, the filters of randomized controlled trials, published between 2002-2021, the year the American College of Obstetrics and Gynecology changed their exercise guidelines, were applied which reduced the finding to 161 results. The 161 remaining studies were reviewed by title and abstract for relevance to the literature review. Studies were excluded for focusing on postpartum exercise, already onset gestational diabetes or a focusing on other maternal complications. The final selection for this review was 19 randomized controlled trials.

Conclusion:

There are many potential benefits, and limited risks without contradictions, of exercise during pregnancy. However, there is not a clear evidence available to support exercise during

pregnancy as a preventive measure for gestational diabetes. Many studies failed to promote adherence to the exercise intervention. Additionally, exercise recommendations during child bearing years may be more appropriate to reduce of risk of gestational diabetes prior to pregnancy. More research should be completed focusing on a consistent exercise prescription to help substantiate the current recommendations.

Table of Contents

List of Figures

List of Tables

Introduction

Exercise during pregnancy is often a discussed topic among health professionals (19). Although the American College of Obstetrics and Gynecology (4), the Academy of Nutrition and Dietetics (20), and the Dietary Guidelines for Americans (28) all recommend regular exercise throughout pregnancy, many women are not meeting the minimum recommendation (19). The inconsistency in research, the recommendation of previous mentioned advising bodies, and lack of adherence in daily exercise among pregnant women illustrates the need to explore the benefits and risks of exercise during pregnancy. Although physical activity outside of pregnancy reduces the risk of Type 2 diabetes (23), previous research has yielded inconclusive results as to if exercise during pregnancy can also reduce the risk of gestational diabetes (8). Some studies have reported exercise improves blood glucose control once gestational diabetes is already on set; however, a clear correlation is not evident to suggest exercise may reduce the risk of gestational diabetes (8). Gestational diabetes causes many complications to both the mother and child (8). If exercise is an appropriate intervention for reducing the risk of gestational diabetes, additional measures must be taken to reduce the prevalence and incidence of gestational diabetes.

Background

According to the Center for Disease Control and Prevention, prenatal complications can develop during pregnancy or stem from a prior condition. Some of the most common complications include anemia, hypertension, gestational diabetes, and excess weight gain (29). There are many potential causes and preventive measures used to limit the prevalence of these complications.

Gestational diabetes is a common maternal complication with increased incidence in recent years. It is estimated that 6-9% of pregnancies will be affected by gestational diabetes (4). This number has grown 10-100% in the last 20 years, varying in severity by race and ethnicity (5). The risk of developing gestational diabetes has increased simultaneously with the increased incidence of Type 2 diabetes. Determining the true incidence of gestational diabetes is a challenge as it is difficult to distinguish a gestational diabetes diagnosis from a missed Type 2 diabetes diagnosis prior to pregnancy (5). Additionally, Type 2 diabetes and pre-diabetes can go asymptomatic for 5-7 years, resulting in a delayed or missed diagnosis (23). Moreover, the observed increased prevalence of gestational diabetes may also be due to an increase in screening that began in the early 1990s (5).

Risk factors for gestational diabetes include: a family history of diabetes, an overweight or obese BMI, increased maternal age, physical inactivity, African American, American Indian, Asian American, Hispanic, Latino, or Pacific Islander ethnicities and/or having pre-diabetes prior to becoming pregnant (16). Poor diet is not a direct risk factor for developing gestational diabetes (24). Gestational diabetes is screened between 24-28 weeks of gestation, the most common time that gestational diabetes is developed (4). According to the American Diabetes Associations, gestational diabetes can be diagnosed through an oral glucose tolerance test (16). In this test, a

woman consumes 100g of glucose. Serum glucose is tested after 1 hour and after 2 hours. The diagnostic criteria after 1 hour are >180 mg/dl and after 2 hours >150 mg/dl or a fasting glucose of >95 mg/dl. For a confirmed diagnosis, two or more criteria must be met. Gestational diabetes can be treated with insulin, medication, such as metformin; carbohydrate counting; exercise and blood glucose monitoring (16).

The etiology of gestational diabetes is a decreased sensitivity to insulin or insulin resistance, which is usually caused by an increase in estrogen and progesterone during early pregnancy (4) which, in turn, causes beta cell hyperplasia and increased insulin production (8). Decreased glucose sensitivity occurs for most women during late pregnancy (4). Women who develop gestational diabetes are at risk for other maternal complications such as hypertension, pre-eclampsia, or cesarean section delivery (4). Additionally, 50% of women with gestational diabetes develop Type 2 diabetes later in life (5).

Children of women who are diagnosed with gestational diabetes have an increased risk of developing obesity and Type 2 diabetes later in life (5). Moreover, women who are diagnosed with gestational diabetes are more likely to give birth to infants who are classified as macrosomia or born greater than 4000 g (4). Macrosomia creates more complicated pregnancies and deliveries and places the child at a greater risk for developing diabetes later in life (4).

Historically, recommendations for exercise during pregnancy were limited. In 2002, the American College of Obstetrics and Gynecology increased their recommendations to 150 minutes per week for women having uncomplicated pregnancies to reduce the risk of common maternal complications (4). Similarly, the 2020 Dietary Guidelines for Americans recommends that women who are pregnant exercise a minimum of 150 minutes per week (28). The position of the Academy of Nutrition and Dietetics matches these guidelines recommending regular exercise

during childbearing years to promote healthy pregnancies (20). Additionally, observational studies have shown that exercise during pregnancy ranging from 30-60 minutes 2-7 days a week may increase the rate of vaginal delivery and decrease the risk of premature birth, caesarean delivery and low birth weight infants (4). However, when surveyed in 2009, 60% of physicians were not familiar with the current recommendation (19). A study, completed across 48 states collected data from 9,953 women, found that 42% of women exercised during pregnancy with the primary type of exercise being walking (38).

The American College of Obstetrics and Gynecology (ACOG) current guidance recommends the inclusion of exercise for most uncomplicated pregnancies. Strength and aerobic exercise are recommended throughout pregnancy with modifications for anatomical and physiological changes that occur. Exercise is recommended for women who exercised prior to pregnancy but also those not exercising regularly. Pregnancy is a great time to start an exercise program as women are already undergoing many changes to better their health for their unborn child creating increased motivation (4). It is recommended that women who have not exercised prior to pregnancy gradually include it in their daily regimen and work up to moderate intensity (4). The American College of Obstetrics and Gynecology guidelines for a safe exercise program during pregnancy are shown in Figure 2.

"In pregnancy, physical inactivity and excessive weight gain have been recognized as independent risk factors for maternal obesity and related pregnancy complications, including gestational diabetes mellitus (GDM)" (4). The current recommendation set by the American College of Obstetrics and Gynecology remains at 150 minutes per week. Examples of exercise include walking, biking and strength training. It is recommended to keep exercise at an intensity rating of 12-14 on the Borg scale, a measure of intensity of exercise (4). The scale ranges from a

6, a resting heart rate, to 20, maximum heart rate intensity (see Figure 1 for an example of a Borg Scale). The recommended 12-14 range is moderate exercise with an increased heart rate, for example, a brisk walk or a slow jog. In this range, the heart rate is increased, however, the participant should be able to carry on a conversation throughout their workout. This moderate range is recommended during pregnancy because pulmonary reserves are reduced. During pregnancy respiratory alkalosis occurs. If exercise is too intense, the alkalosis may not be able to compensate, and acidosis could occur (11). Acidosis causes symptoms of dizziness, confusion and shortness of breath. This occurs because of the decrease in pulmonary reserves and oxygen available is reduced causing the maximum effort during pregnancy to be reduced (11). Additionally, it is recommended to avoid exercise in the supine position because the position may cause supine hypotension syndrome to the mother and risk to the child (4).

Gestational diabetes is a significant public health concern. Many resources are needed to help treat and prevent further complications of women who are diagnosed. Prevention is key to help reduce the risk and lessen the public health burden. Two factors that may reduce the risk are diet and physical activity (10). Many studies have been inconclusive in providing evidence that exercise may reduce the risk of gestational diabetes, however, it may help manage it (19). The goal of this review was to review the current research available to evaluate whether exercise is a realistic intervention for women who are pregnant to reduce the risk of gestational diabetes.

Figure 1.

An Example of a Borg Scale to Measure Intensity of Exercise (4)

6	
7	Very, very light
8	
9	Very light
10	
11	Fairly light
12	
13	Somewhat hard
14	
15	Hard
16	
17	Very hard
18	
19	Very, very hard
20	

Reprinted from Borg GA. Psychophysical bases of perceived exertion. Med Sci Sports Exerc 1982;14:377–81.

Figure 2.

The American College of Obstetrics and Gynecology Guidelines for Exercise during Pregnancy (4)

When to Start	First Trimester, More Than 12 Weeks of gestation
Duration of a session	30–60 minutes
Times per week	At least 3–4 (up to daily)
Intensity of exercise	Less than 60–80% of age-predicted maximum maternal heart rate*
Environment	Thermoneutral or controlled conditions (air conditioning; avoiding prolonged exposure to heat)
Self-reported intensity of exercise (Borg scale)	Moderate intensity (12–14 on Borg scale)
Supervision of exercise	Preferred, if available
When to end	Until delivery (as tolerated)

*Usually not exceeding 140 beats per minute.

Modified from Berghella V, Saccone G. Exercise in pregnancy! Am J Obstet Gynecol 2017;216:335–7.

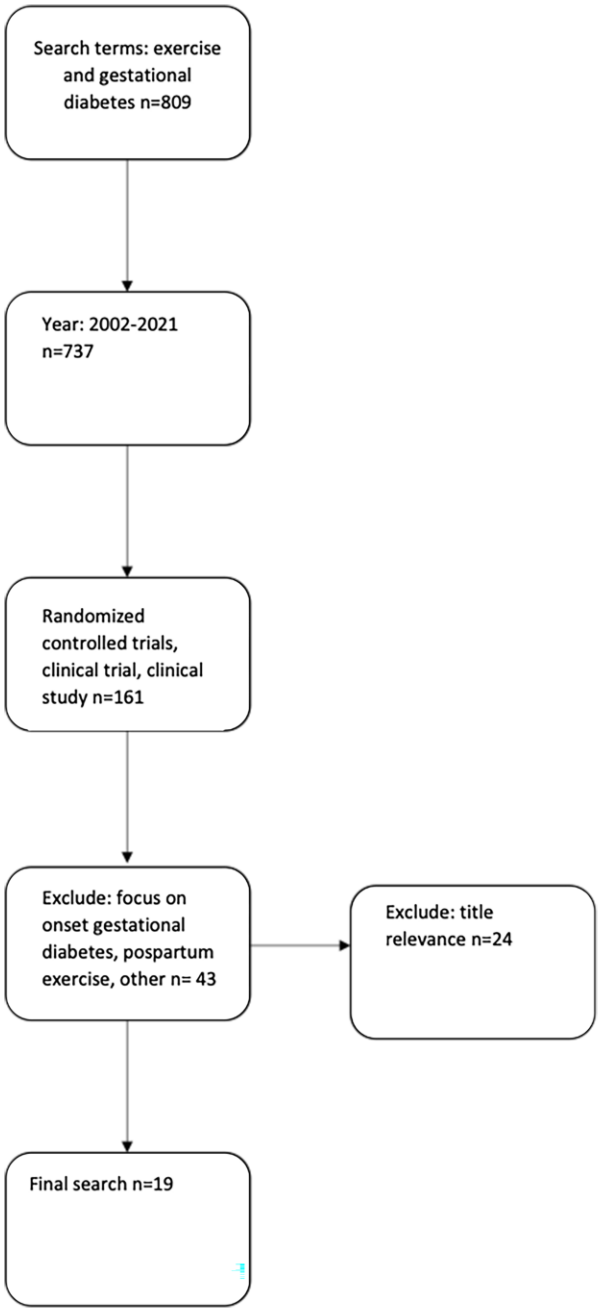
Methodology

The research for this review was conducted through PubMed. The search was limited to studies published between 2002-2021. The year 2002 was when the American College of Obstetrics and Gynecology updated their recommendation for exercise during pregnancy. The relevant MeSH terms used included “Exercise,” and “Diabetes, Gestational.” Prior to filtering, the initial search yielded 809 results. The following filters were then applied “Controlled Clinical Trials,” “Clinical Trials,” “Clinical Study.” The final two filters limited the studies to “English,” and “Female”, resulting in 161 studies. The remaining studies were then reviewed by title for relevance in the literature review. One hundred and eighteen studies were excluded due to irrelevance. Studies were excluded for focusing on the treatment of onset gestational diabetes, postpartum exercise and focusing on other maternal complications.

There were no restrictions applied for length of study or sample size. The remaining 43 studies were evaluated by reviewing the abstracts. Twenty-four studies were excluded for focusing on gestational weight gain, diet and efficacy of metformin. The remaining 19 studies were used for this literature review.

Figure 3.

A Flowchart Showing the Methodology Taken in Search for This Review



Results

The initial PubMed search yielded 809 studies. After narrowing down the results with exclusion and inclusion criteria, 19 studies were chosen for this review of literature. The chosen studies are summarized in Table 1.

Table 1.

A Summary of Results across 5 Randomized Controlled Clinical Trials with Lifestyle Counseling Intervention

Study	Study Type	Sample Size/ Gestation Period	Sample Characteristics	Exercise Type	Sample Adherence and factors of Adherence	GDM Incidence	Other results
Dodd et al 2019 (8)	Randomized control trial	n=654 first antenatal-delivery	Average Age 31.6 Average BMI 22.2 kg/m2	Lifestyle intervention; counseling on diet and exercise	n/a	No significant differences.	No significant differences
Harrison et al 2015 (17)	Randomized control trial	n=228 12-15 to 26-28 weeks of gestation	Average age 31.7 Average BMI 30.3	Counseling session to increase physical activity (pedometer worn)	n/a	Gestational diabetes incidence was lower in the intervention group. P=0.1	Overweight women in the control group gained more weight than overweight women in the intervention group.
Hawkins et al 2015 (18)	Randomized control trial	N=68 began intervention prior to 18 weeks of gestation to delivery	BMI 18-40 kg/m2 overweight/obese Less than 30 minutes of exercise a week	Lifestyle intervention; 6 monthly in person counseling sessions promoting physical activity and heart healthy diet	Higher vigorous exercise noted in the intervention group.	No statically significant reduce in gestational diabetes.	Intervention group gained less gestational weight

Kennelly et al 2018 (21)	Randomized control trial	N=565 10-15 to 36 weeks' gestation	BMI 25-39.9 kg/m2 with average 29.3 kg/m2 Average Age 32.8	Lifestyle counseling intervention through mobile application, one on one and group counseling, recommended 30 minutes of exercise 5-7 days a week	Not calculated, intervention group had higher self-reported exercise specifically in the third trimester compared to the control.	No statistically significant difference between intervention 15.4% incidence and control 14.1% incidence P=0.71	n/a
Sahrakorpi et al 2019 (31)	Randomized control trial	N=378 before 20 weeks' gestation to delivery	High risk for gestational diabetes Average BMI 32.6 kg/m2 Average age 32.6	Lifestyle intervention individualized diet and exercise counseling recommended 150 minutes of moderate exercise / week	n/a noted that the sample population had greater motivation to exercise because of risk of gestational diabetes; however, many barriers were present including fear of safety.	Intervention group had incidence of 45.7% compared to control 44.5% No statically significant difference	** population was at high risk for developing gestational diabetes potential for confounding results

Table 2.

A Summary of Results across 6 Randomized Controlled Clinical Trials with Structured Exercise Intervention and High Adherence

Study	Study Type	Sample Size/ Gestation Period	Sample Characteristics	Exercise Type	Sample Adherence and factors of Adherence	GDM Incidence	Other results
Barakat et al 2015 (2)	Randomized control trial	N=510 began intervention 12-36 weeks of gestation	Sedentary lifestyle, uncomplicated pregnancies, average age 31, average BMI 24 kg/m2	Moderate intensity exercise 3 x a week for 50-55 minutes includes aerobic and strength training	Adherence > 95% noted that they created a fun environment to promote adherence and sectioned groups to 10-12 women	Intervention did not reduce gestational diabetes risk OR 0.84 CI .5-1.4 (not statically significant)	n/a
Barakat et al 2019 (3)	Randomized control trial	n=456 8-10 to 38-39 weeks' gestation	Average age 31.0 BMI Less than 18 2.7% 18-24.9 mg/k2 70.7% 25-29.9 mg/k2 20.3% More than 30 mg/k2 6.3%	Moderate aerobic exercise 3X a week	>80% adherence rate	Gestational diabetes incidence control group 6.8% compared to intervention group 2.6%. CI 0.138–0.953; $p = 0.033$	Women in the intervention group gained less excess gestational weight 20.5% compared to control of 30.2%.
Callaway et al	Randomized control trial	N=50 12-36		Individualized exercise program with	73%	No statistically significant difference	n/a

2010 (6)		weeks' gestation		goal energy expenditure of 900kcal/week		between intervention and control group.	
Guelfi et al 2016 (15)	Randomized controlled trial	n=172 13+ weeks of gestation	Average age 33.8 BMI 55 % normal 22 % overweight 23% obese	14 weeks cycling intervention 3X week	86% adherence or more	Intervention group did not have a lower incidence compared to the control group	The intervention group displayed greater physical fitness & psychological well-being.
Pelaez et al 2019 (27)	Randomized control trial	N=345 began intervention 12-14 weeks of gestation to delivery	18+ uncomplicated pregnancies	70-78 sessions, 3x week for 1 hour for 24 weeks moderate to vigorous structured exercise	Adherence 95%	Not statistically significant difference between the two groups	Less women in the intervention group gained excess gestational weight 22% vs 80% P=0.001
Wang et al 2017 (37)	Randomized control trial	n=300 12-37 weeks of gestation	Average age 32.1 Average BMI 26.8 26% obese with BMI > 28kg/m2	3X a week cycling exercise for 30 minutes at 12-14 on Borg scale	>80%	Women in exercise group had 22.0% incidence of gestational diabetes: 40.6% in control group P <0.001	Intervention group had less gestational weight gain & reduced insulin resistance.

Table 3.

A Summary of Results across 8 Randomized Controlled Clinical Trials with Structured Exercise Intervention and Low Adherence Rate

Study	Study Type	Sample Size/ Gestation Period	Sample Characteristics	Exercise Type	Sample Adherence and factors of Adherence	GDM Incidence	Other results
Cordero et al 2015 (7)	Randomized control trial	N=342 10-12 weeks' gestation to delivery	Average age 33.2 No complications Limited exercise prior to intervention Average BMI 22.5 kg/m2	3x a week 50-60 minutes at 12-14 intensity on Borg scale workouts were at gym or aquatic center	n/a	Interventi on had 1% incidence compared to control of 8.8% P=0.009	Intervention group had lower gestational weight gain compared to control.
Embaby et al 2016 (8)	Randomized controlled trial	n=40 20-24 to 27 weeks of gestation	Average age 28.3 Average BMI 28.3 kg/m2	Aerobic training (treadmill walking) 3 X a week for 45 minutes	n/a	Women in the interventio n group had a lower incidence of gestational diabetes P=0.0001.	n/a
Garnæs et al 2016 (11)	Randomized control trial	n=91 women 12-18 to 34-	Average age 31.6	3X a week strength and	50% adherence	Gestationa l diabetes incidence	Systolic blood pressure was significantly

		27 weeks of gestation	Average BMI 33.3 kg/m2	endurance training.		in the intervention group (6.1%) compared to the control group (27.3%) CI 0.02, 0.95; *p* = 0.04	lower in the intervention group.
Nobles et al 2015 (26)	Randomized control trial	n=352 began at 18 weeks of gestation	Average Age 27 BMI 3% less than 25 kg/m2 34.7% 25-30 kg/m2 62.2% 30-40 kg/m2	Individual exercise program that met ACOG guidelines	62% adherence	No statistically significant difference between intervention and control groups	n/a
Price et al 2012 (30)	Randomized control trial	N=62 began intervention 12-14 weeks of gestation to delivery	Inactive, no more 1x week exercise BMI less than 39 Uncomplicated pregnancies average age 30	45-60 minutes structed exercise 4 days a week 3 sessions of aerobic/strength training and 1 walk	Adherence was affected by transportation, conflicts and employment	No significant difference between 2 groups	**noted that women reported to receive mixed messaged about the safety and importance of exercise

							during pregnancy
Simmons et al 2014 (34)	Randomized Controlled Trial	n=436 <20 weeks' gestation to 35-37 weeks	Average age 31.8, average pregnancy BMI 33.4 mg/k2	Aerobic and resistance training.	n/a	No significant differences	Healthy eating combined with physical activity may improve gestational weight gain but not gestational diabetes incidence.
Stafne et al 2012 (35)	Randomized control trial	N=855 18–22-week gestation 12-week intervention	Average BMI=24.7 kg/m2 Age 18+ with average age 30.5 Singleton uncomplicated pregnancy	3x a week structured exercise for 60 minutes 1 exercise at studio 2 take home works outs	55% followed protocol 10% of control group included exercise on own 32% of women exercised prior to pregnancy	No statistically significant difference between intervention and control groups	No adverse effects of exercise No differences in gestational weight gain

Structured Exercise Intervention

Each study followed the recommended exercise guidelines, set by the American College of Obstetrics and Gynecology, of approximately 150 minutes a week (14). The studies varied on the type of exercise and whether it was structured or unstructured. Most studies included both strength and aerobic training. Of the studies that reported adherence rate, the average was 70%.

The studies conducted by Shana Ginar da Silva (6) et al, Garnæs et al (11), Stafne et al (35), Cordero et al (7), Pelaez et al (27), Price et al (30) and Barakat et al (3,2) utilized a structured exercise program several times a week, in addition to standard prenatal care. In each of these interventions, the session included strength, aerobic and flexibility training. The control group received standard prenatal care and was instructed to continue living their normal daily lives. Similarly, the intervention used by Embaby et al provided structured exercise namely, a steady walk on the treadmill for 45 minutes, 3 times a week. In this study, the women were instructed to eat a meal 1-3 hours before exercise (8). In the study completed by Callaway et al the women in the intervention group had individual exercise prescriptions with a goal weekly caloric expenditure of 900 kcal (6). The intervention by Stafne et al provided one weekly in person structured workout out and the remaining two workouts were completed at home (35).

The study designed by Guelfi et al included riding a stationary bike at the intensity of 9-11 on the Borg scale. The program included three workouts a week, completed at the participants' home, for 14 consecutive weeks with each session supervised by an exercise physiologist (15). Wang et al also introduced a cycling intervention three times a week for 30 minutes at a 12-14 on the Borg scale, (37).

Lifestyle Counseling Intervention Exercise Intervention

The intervention used by Simmons et al (34), Dodd et al (8), Hawkins et al (18), Kennelly et al (21), Harrison et al (17) and Sahrakorpi et al (31) were all counseling-based lifestyle interventions. The intervention group in Simmons et al (34) was randomly assigned to one of 3 exposures: a physical activity exposure, physical activity and healthy eating exposure, or control. This study did not have a structured exercise program. Instead, it provided informational sessions on physical activity in daily life. Exercise completed was assessed by the use of Pregnancy Physical Activity Questionnaire (34).

The study completed by Dodd et al (8) and Harrison et al (17) provided one-on-one sessions introducing physical activity and healthy eating recommendations. The study by Dodd et al (8) found that women in the intervention group did not have greater physical activity than those in the control group; however, the intervention group in the study completed by Harrison et al (17) had 20% more steps a day on average compared to the control group.

The study completed by Kennelly et al (21) provided diet and exercise-based support through a mobile application. The intervention group was counseled one on one or in small groups. Similarly, Hawkins et al (18) provided 6 monthly one-on-one counseling sessions on physical activity and heart healthy diets.

Lastly, the study by Nobles et al included counseling on lifestyle intervention. The exercise intervention group received an individualized plan that met the guidelines set by the American College of Obstetrics and Gynecology (26).

Sample BMI & Risk Factors Prior to Study

An obese or overweight BMI is a risk factor for developing gestational diabetes during pregnancy (14). The studies varied on their sample BMI. Some studies included just overweight or obese BMI (6, 9, 10, 3, 26,17, 20), some included solely normal (8) and others a combination (15, 9,37).

The study completed by Ginar da Silva et al (6), Caraway et al (6), Stafne et al (35) and Barakat et al (3) used a sample consisting of women with a BMI < 35 kg/m2. The study completed by Guelfi et al (15) and Sahrakorpi et al (31) included women in each BMI category who had a history of gestational diabetes in a previous pregnancy. Similarly, the studies by Embaby et al (9) and Nobles et al (26) and Harrison et al (17), included women who were at risk for developing gestational diabetes. These women had a BMI > 30 mg/kg^2 and one or more additional risk factors including a history of macrosomia, abnormal glucose tolerance, or a family history of type 2 diabetes Simmons et al (34) and Wang et al (37) included women with a BMI of overweight but not obese. Garnæs et al included women with BMI > 28 kg/m^2 (11). The study completed by Dodd et al was the only study to only include women with a normal BMI (8).

Adherence to studies

The adherence to the intervention ranged drastically across the studies. The adherence ranged from 40%-95%. Adherence is an important factor in determining if the intervention is realistic for the population. Low adherence rates also reduce statistical significance.

The study conducted by Ginar da Silva et al used additional measures to help with adherence to their study (6). They provided exercise clothing as well as transportation to the

exercise site. Even with the additional protocol in place only 40.4% of the women attended 70% or more of the recommended work out sessions. This was far below their goal adherence rate (6). Garnæs et al had a low adherence rate as well. They found that only 50% of the women attended the recommended sessions (11). Similarly, Stafne et al found only 55% of the women attended the recommended sessions (35). Price et al did not calculate an adherence rate; however, they noted that their participants received mixed messages about the safety of exercise during pregnancy as well as factors which may have limited their adherence. These factors included transportation, time conflict and employment (30). Limited adherence may also be attributed to pregnancy related symptoms such as lack of energy, thoracic pain or lack of motivation.

The study completed by Guelfi et al provided a home-based exercise program to improve adherence. This study was unique in that all the women all had additional children at home. The convenience of the exercise professional going to the participants home to complete the exercise session promoted an 86% adherence rate (15). Wang et al (37) and Barakat et al (3) also had a high adherence rate of 80%. Palaez et al (27) and Barakat et al (2) both reported a 95% adherence rate. Barakat et al provided small group exercise programs in well-lit rooms with fun music to promote adherence. Caraway et al also had a high adherence rate having 73% of the women burning approximately 900kal weekly (6).

The lifestyle intervention-based studies did not provide typical adherence rates however, they were able to compare self-reported physical activity. The study completed by Kennelly et al found that the intervention group had higher self-reported physical activity in the third trimester compared to the control group (21). Hawkins et al found that women in the intervention group had an increase in weekly vigorous activity (18). Sahrakorpi et al did not calculate adherence

but it was noted that their sample population may have had greater motivation due to risk of gestational diabetes and that a limiting factor was fear of safety.(31)

Gestational Diabetes Incidence

Many of the studies reviewed were unable to find significant evidence that exercise can reduce the risk of gestational diabetes. Moreover, the studies had many sample dropouts and low adherence rates. For example, the study completed by Ginar da Silva et al found that the results of their structured exercise program were not statistically significant. In this study, gestational diabetes was defined by self-reporting yes or no in a face-to-face interview 48 hours after delivery (6). Callaway et al was unable to find a significant difference in gestational diabetes incidence between the intervention and control group (6).

Guelfi et al defined gestational diabetes as a fasting blood glucose > 99 mg/dL or a 2-hour OGTT > 144 mg/dL (15). There was no significant difference found in gestational diabetes incidence between the intervention and control groups (15). Similarly, the study completed by Simmons et al (34) and Nobles et al (26) found that women in the Physical Activity group did not see improved glucose levels or reduced risk developing gestational diabetes. Stafne et al (35), Kennelly et al (21), Sahrakorpi et al (31), Price et al (30) found no significant differences between intervention and control groups.

Conversely, the study conducted by Embaby et al found that women in the intervention had lower fasting blood glucose and fasting insulin levels (9). The intervention group had fasting blood glucose levels of (6.5+/- 0.9mmol/L, 4.3+/-0.7mmol/L) compared to the control of (6.55±0 .95, 5.07±0.54). The intervention group had fasting insulin levels of (16.3 +/-0.9 mmol/L,10.6 +/-1.1 mmol/L) compared to the control group of (15.3+/- 2.3 mmol/L, 12.4+/-1.4 mmol/L) (9).

Garnæs et al found that women in the intervention group had significantly less incidence of gestational diabetes compared to the control based on the World Health Organization's 2009 guideline for diagnosing gestational diabetes but not based on the 2013 guidelines (11). Wang et al found that women in the intervention group had significantly lower incidence of gestational diabetes at 22.0%, compared to that of the control group, 40.6% with P< 0.001, (37). Cordero et al (7) found the intervention group had 7.8% lower incidence. Finally, Barakat et al (3) found that women in the intervention group had a lower incidence of gestational diabetes (2.6%) compared to the control group (6.8%) and Harrison et al (17) found the intervention group had 8 less cases of gestational diabetes (p=.1).

Other Relevant Information Found

The study completed by Ginar da Silva et al found exercise did not affect gestational age or preterm birth incidence (6). Additionally, none of the studies examined found any adverse effects of including exercise during pregnancy. During the trial by Guelfi et al the 21-item Depression Anxiety Stress Scale was administered. They found that women in the intervention group showed a reduced score (p=0.04), compared to that of the control group (15). The studies completed by Simmons et al, Wang et al, Barakat et al Harrison et al found that women in the intervention group had lower gestational weight gain (9, 37, 3, 17). Garnæs et al found that women in the intervention group had significantly lower systolic blood pressure when compared to that of the control group (11).

Discussion

The purpose of this literature review was to evaluate exercise during pregnancy as an effective intervention to reduce the risk of gestational diabetes. Nineteen studies examining the effects of exercise on pregnant women with varying BMIs and risk factors were reviewed. The studies were all randomized controlled trials providing a high level of evidence; however, the studies had many sample dropouts and struggled to promote adherence to the exercise regimens. The studies varied in exercise style and duration. Many studies were unable to provide statistically significant evidence to support exercise as a factor to reduce the incidence of gestational diabetes during pregnancy. Only six out of nineteen studies found that exercise positively affected gestational diabetes incidence. None of the studies found significant adverse maternal or neonatal outcomes due to the exercise promotion.

Strengths and Limitations

A strength of this research was that the studies were all randomized control trials focusing on the use of exercise during pregnancy to help prevent gestational diabetes. Many previous studies explored the safety of exercise during pregnancy rather than the benefits (6). The studies that included the use of an exercise professional provided additional benefits because it helped to accurately track the adherence to the regimen (6, 15, 11, 37, 3). By including an exercise professional, the workouts were tracked and able to be repeated in future research.

During this review of literature, many limitations were found in the selected studies. The varying randomized controlled trials had low adherence rates causing them to have low statistical significance (6, 11). The studies varied in the BMI of the sample sizes. Eighteen out of nineteen

studies included women having an overweight or obese BMI. These women are at higher risk of developing gestational diabetes compared to women with normal BMI which could confound results. Only one study included women with a normal BMI (8). The studies completed by Embaby et al (9) and Guelfi et al (15) included women who had gestational diabetes in previous pregnancies which put the women at even higher risk for developing gestational diabetes potentially confounding the results (15, 9).

Inclusion of Dietary Recommendations

Several studies included diet regimens into their intervention. Simmons et al used intervention groups of healthy eating and healthy eating and physical activity (34). Dodd et al added lifestyle counseling to the intervention and saw improvement in diet through the healthy eating index; however, they did not find a significant difference between the group's incidence of gestational diabetes or other maternal complications (8). Nobles et al implemented diet and exercise changes; this study did not find any significant changes between the intervention and control group, (26). It is likely a counseling intervention is not a sufficient intervention to improve gestational diabetes incidence. The Guelfi et al study design included a 7-day food diary to account the diet differences between the intervention and the control groups. Food diaries carry the limitation of food being under or over reported (15).

Lifestyle Intervention or Structured Exercise

Dodd et al (8) , Sahrakorpi et al (31), Kennelly et al (21) and Nobles et al (26) all focused on total lifestyle changes. These randomized controlled trials were counseling sessions compared to the other studies reviewed that were structured exercise programs that did not find any

significant changes between the control group and intervention group. Harrison et al (17) and Kennelly et al (21) both found an improvement in physical activity but not gestational diabetes incidence. A counseling intervention provides a realistic clinical approach that can be used outside of a clinical trial. The studies that included structured exercise programs are less likely to be used in a clinical setting, however, are needed to set the standards for recommendation.

Limitations to Adherence Rates

In general, these randomized controlled trials struggled with adherence rates, making the studies weak in supporting exercise as a realistic intervention for preventing gestational diabetes (6, 11). Barakat et al (3) and Wang et al (37) were the only two studies that were able to provide high adherence rates for an intervention that required the participants to go to a location to exercise. Both studies found a significant reduction in gestational diabetes in the intervention group compared to the control group. In the study completed by Shana Ginar da Silva, many women reported that they discontinued exercise due to advice from their medical provider (6). Moreover, only 28.1% of women reported to have been encouraged to exercise from their medical provider (6).

There are many factors that could limit women from exercising during pregnancy. Many women reported that they have heard conflicting information about the safety of exercise (30). Employment, having other children at home, nausea, fatigue and marital status may also affect a woman's ability to exercise during pregnancy (26, 36).

Similar Literature Review Results

Many other literature reviews have been completed on the topic of exercise as an intervention for preventing gestational diabetes. A meta-analysis completed by Halperin et al found that observational studies show a positive correlation between exercise and the reduction of gestational diabetes; however, when studied as a randomized control trial, the results are not as prevalent (16). It was concluded that randomized controlled trials do not have the same results likely due to the limited power and low adherence rates to interventions (16). There may also be differences in the sample population that account for decreased risk. The study concluded that exercise during pregnancy is still recommended to reduce risk of complications due to excess gestational weight gain but not specifically to reduce the risk of gestational diabetes (16).

The study completed by Sanabria-Martinez et al reviewed randomized controlled trials that included healthy women with limited physical activity prior to pregnancy (32). This study found that structured exercise reduced the risk of developing gestational diabetes when completed throughout pregnancy. This study found that exercise reduces the risk of developing gestational diabetes by 31% (32). The study concluded that exercise should be recommended early in pregnancy to promote health for both mother and child (32)

A meta-analysis completed by Nasiri-Amiri et al found that an exercise intervention did not affect the incidence of gestational diabetes but relative risk of developing gestational diabetes was 24% lower in the intervention group compared to the control (25). This study found that exercising three times a week or less could improve the risk of developing gestational diabetes; however, an increase beyond three times a week may have the inverse effect (25). It was concluded that hormones play a significant role in the development of gestational diabetes and that more research is needed to provide a clear recommendation (25).

In the meta-analysis completed by Mijatovic-Vukas et al both physical activity and diet in relation to gestational diabetes were studied (23). This study found that in 13 out of 17 studies, exercise was a protective factor in preventing gestational diabetes. The study focused on leisure time physical activity rather than structured exercise. It was found that the higher the activity level, the lower the risk for gestational diabetes (23). Given limitations of the study, it was concluded that physical activity should be increased prior to conception to improve overall gestational diabetes risk (23).

Future Research Recommendations

Many studies, even with high adherence rates, were unable to find a statically significant reduction in gestational diabetes incidence. The study by Barakat et al had an adherence rate of greater than 95% and still found that exercise did not reduce the risk of gestational diabetes (2). More research should be completed on the timing of exercise. Promoting exercise prior to pregnancy could lower BMI prior to pregnancy and minimize the risk factors of developing gestational diabetes (16).

.

Conclusion

There are many factors that contribute to gestational diabetes. There is conflicting evidence that exercise may reduce the risk; however, none of the studies reported adverse complications due to implementing an exercise regimen, supporting exercise during pregnancy. Four studies reported lower gestational weight gain for women in the intervention group (9, 12, 3, 17). Additionally, only six of these studies reported less incidence of gestational diabetes (8, 11 ,37 ,3, 17, 25). This supports the fact that gestational diabetes has many causes stemming from varying risk factors. It is challenging to find one intervention to help reduce the risk of gestational diabetes. Diabetes prevention requires a multifaceted approach including preconception intervention supporting the position of the Academy of Nutrition and Dietetics that exercise should be included beginning in childbearing years (20).

Most studies included in this review had many sample dropouts, small sample sizes, and low adherence rates which limits the statistical power of the studies and implies that exercise may not be the best recommendation for reducing the risk of gestational diabetes. Physician support plays an important role in promoting exercise. Many women question the safety of exercise during pregnancy creating the need for a unified approach.

More research needs to be conducted on the ideal exercise prescription as well as introducing exercise prior to conception. Exercise should still be a recommendation during pregnancy due to other potential benefits and limited risk during uncomplicated pregnancies. However, based on this literature review, there is not enough evidence that exercise alone can reduce the risk of developing gestational diabetes.

References

1. American Diabetes Association. (2021, January 01). Standards of Medical Care in Diabetes-2021 Abridged for Primary Care Providers. Retrieved July 7, 2021, from https://clinical.diabetesjournals.org/content/39/1/14

2. Barakat, R., Pelaez, M., Lopez, C., Lucia, A., & Ruiz, J. R. (2013). Exercise during pregnancy and gestational diabetes-related adverse effects: A randomised controlled trial. *British Journal of Sports Medicine,47*(10), 630-636. doi:10.1136/bjsports-2012-0917

3. Barakat, R., Refoyo, I., Coteron, J., & Franco, E. (2019). Exercise during pregnancy has a preventative effect on excessive maternal weight gain and gestational diabetes. A randomized controlled trial. *Brazilian Journal of Physical Therapy,23*(2), 148-155. doi:10.1016/j.bjpt.2018.11.005

4. Birsner, M. L., & Gyamfi-Bannerman, C. (2020, April). Physical Activity and Exercise During Pregnancy and the Postpartum Period. Retrieved July 7, 2021, from https://www.acog.org/clinical/clinical-guidance/committee-opinion/articles/2020/04/physical-activity-and-exercise-during-pregnancy-and-the-postpartum-period

5. Birsner, M. L., & Gyamfi-Bannerman, C. (2020, April). Physical Activity and Exercise During Pregnancy and the Postpartum Period. Retrieved July 7, 2021, from https://www.acog.org/clinical/clinical-guidance/committee-opinion/articles/2020/04/physical-activity-and-exercise-during-pregnancy-and-the-postpartum-period

6. Callaway, L. K., Colditz, P. B., Byrne, N. M., Lingwood, B. E., Rowlands, I. J., Foxcroft, K., & Mcintyre, H. D. (2010). Prevention of Gestational Diabetes: Feasibility issues for an exercise intervention in obese pregnant women. *Diabetes Care,33*(7), 1457-1459. doi:10.2337/dc09-2336

7. Cordero, Y., Mottola, M. F., Vargas, J., Blanco, M., & Barakat, R. (2015). Exercise Is Associated with a Reduction in Gestational Diabetes Mellitus. *Medicine & Science in Sports & Exercise,47*(7), 1328-1333. doi:10.1249/mss.0000000000000547

8. Dodd, J. M., Deussen, A. R., & Louise, J. (2019). A Randomised Trial to Optimise Gestational Weight Gain and Improve Maternal and Infant Health Outcomes through Antenatal Dietary, Lifestyle and Exercise Advice: The OPTIMISE Randomised Trial. *Nutrients,11*(12), 2911. doi:10.3390/nu11122911

9. Embaby, H., Elsayed, E., & Fawzy, M. (2016). Insulin sensitivity and plasma glucose response to aerobic exercise in pregnant women at risk for gestational diabetes mellitus. *Ethiopian Journal of Health Sciences,26*(5), 409. doi:10.4314/ejhs.v26i5.2

10. Ferrara, A. (2007, July 01). Increasing Prevalence of Gestational Diabetes Mellitus. Retrieved July 7, 2021, from https://care.diabetesjournals.org/content/30/Supplement_2/S141

11. Garnæs, K. K., Mørkved, S., Salvesen, Ø, & Moholdt, T. (2016). Exercise Training and Weight Gain in Obese Pregnant Women: A Randomized Controlled Trial (ETIP Trial). *PLOS Medicine,13*(7). doi:10.1371/journal.pmed.1002079

12. Gestational Diabetes Mellitus (GDM). (n.d.). Retrieved July 7, 2021, from https://www.hopkinsmedicine.org/health/conditions-and-diseases/diabetes/gestational-diabetes

13. Gestational Diabetes Mellitus. (2003, January 01). Retrieved July 7, 2021, from https://care.diabetesjournals.org/content/26/suppl_1/s103

14. Gestational Diabetes. (2021, August 10). Retrieved September 10, 2021, from https://www.cdc.gov/diabetes/basics/gestational.html

15. Guelfi, K. J., Ong, M. J., Crisp, N. A., Fournier, P. A., Wallman, K. E., Grove, J. R., . . . Newnham, J. P. (2016). Regular Exercise to Prevent the Recurrence of Gestational Diabetes Mellitus. *Obstetrics & Gynecology,128*(4), 819-827. doi:10.1097/aog.0000000000001632

16. Halperin, I. J., & Feig, D. S. (2013). The Role of Lifestyle Interventions in the Prevention of Gestational Diabetes. *Current Diabetes Reports,14*(1). doi:10.1007/s11892-013-04522

17. Harrison, C. L., Lombard, C. B., Strauss, B. J., & Teede, H. J. (2013). Optimizing healthy gestational weight gain in women at high risk of gestational diabetes: A randomized controlled trial. *Obesity,21*(5), 904-909. doi:10.1002/oby.20163

18. Hawkins, M., Hosker, M., Marcus, B. H., Rosal, M. C., Braun, B., Stanek, E. J., . . . Chasan-Taber, L. (2014). A pregnancy lifestyle intervention to prevent gestational diabetes risk factors in overweight Hispanic women: A feasibility randomized controlled trial. *Diabetic Medicine,32*(1), 108-115. doi:10.1111/dme.12601

19. Hinman, S. K., Smith, K. B., Quillen, D. M., & Smith, M. S. (2015). Exercise in Pregnancy. *Sports Health: A Multidisciplinary Approach,7*(6), 527-531. doi:10.1177/1941738115599358

20. Kaiser, L. L., & Campbell, C. G. (2014). Practice Paper of the Academy of Nutrition and Dietetics Abstract: Nutrition and Lifestyle for a Healthy Pregnancy Outcome. *Journal of the Academy of Nutrition and Dietetics,114*(9), 1447. doi:10.1016/j.jand.2014.07.001

21. Kennelly, M. A., Ainscough, K., Lindsay, K. L., Osullivan, E., Gibney, E. R., Mccarthy, M., . . . Mcauliffe, F. M. (2018). Pregnancy Exercise and Nutrition With Smartphone Application Support. *Obstetrics & Gynecology,131*(5), 818-826. doi:10.1097/aog.0000000000002582

22. Luoto, R. M., Kinnunen, T. I., Aittasalo, M., Ojala, K., Mansikkamäki, K., Toropainen, E., . . . Vasankari, T. (2010). Prevention of Gestational Diabetes: Design of a Cluster-Randomized Controlled Trial and One-Year Follow-Up. *BMC Pregnancy and Childbirth,10*(1). doi:10.1186/1471-2393-10-39

23. Mijatovic-Vukas, J., Capling, L., Cheng, S., Stamatakis, E., Louie, J., Cheung, N., . . . Flood, V. (2018). Associations of Diet and Physical Activity with Risk for Gestational Diabetes Mellitus: A Systematic Review and Meta-Analysis. *Nutrients,10*(6), 698. doi:10.3390/nu10060698

24. Moses, R. G., & Brand-Miller, J. C. (2009). Dietary Risk Factors for Gestational Diabetes Mellitus: Are sugar-sweetened soft drinks culpable or guilty by association? *Diabetes Care,32*(12), 2314-2315. doi:10.2337/dc09-1640

25. Nasiri-Amiri, F., Sepidarkish, M., Shirvani, M. A., Habibipour, P., & Tabari, N. S. (2019). The effect of exercise on the prevention of gestational diabetes in obese and overweight pregnant women: A systematic review and meta-analysis. *Diabetology & Metabolic Syndrome,11*(1). doi:10.1186/s13098-019-0470-6

26. Nobles, C., Marcus, B. H., Stanek, E. J., Braun, B., Whitcomb, B. W., Solomon, C. G., . . . Chasan-Taber, L. (2015). Effect of an Exercise Intervention on Gestational Diabetes Mellitus. *Obstetrics & Gynecology,125*(5), 1195-1204. doi:10.1097/aog.0000000000000738

27. Pelaez, M., Gonzalez-Cerron, S., Montejo, R., & Barakat, R. (2019). Protective Effect of Exercise in Pregnant Women Including Those Who Exceed Weight Gain Recommendations: A Randomized Controlled Trial. *Mayo Clinic Proceedings,94*(10), 1951-1959. doi:10.1016/j.mayocp.2019.01.050

28. Phillips, J. A. (2021). Dietary Guidelines for Americans, 2020–2025. *Workplace Health & Safety,69*(8), 395-395. doi:10.1177/21650799211026980

29. Pregnancy Complications. (2020, August 13). Retrieved July 7, 2021, from https://www.cdc.gov/reproductivehealth/maternalinfanthealth/pregnancy-complications.html

30. Price, B. B., Amini, S. B., & Kappeler, K. (2012). Exercise in Pregnancy. *Medicine & Science in Sports & Exercise,44*(12), 2263-2269. doi:10.1249/mss.0b013e318267ad67

31. Sahrakorpi, N., Rönö, K., Koivusalo, S. B., Stach-Lempinen, B., Eriksson, J. G., & Roine, R. P. (2018). Effect of lifestyle counselling on health-related quality of life in women at high risk for gestational diabetes. *European Journal of Public Health,29*(3), 408-412. doi:10.1093/eurpub/cky248

32. Sanabria-Martínez, G., García-Hermoso, A., Poyatos-León, R., Álvarez-Bueno, C., Sánchez-López, M., & Martínez-Vizcaíno, V. (2015). Effectiveness of physical activity interventions on preventing gestational diabetes mellitus and excessive maternal weight

gain: A meta-analysis. *BJOG: An International Journal of Obstetrics & Gynaecology,122*(9), 1167-1174. doi:10.1111/1471-0528.13429

33. Silva, S. G., Hallal, P. C., Domingues, M. R., Bertoldi, A. D., Silveira, M. F., Bassani, D., . . . Evenson, K. (2017). A randomized controlled trial of exercise during pregnancy on maternal and neonatal outcomes: Results from the PAMELA study. *International Journal of Behavioral Nutrition and Physical Activity,14*(1). doi:10.1186/s12966-017-0632-6

34. Simmons, D., Devlieger, R., Assche, A. V., Jans, G., Galjaard, S., Corcoy, R., . . . Poppel, M. N. (2016). Effect of physical activity and/or healthy eating on GDM risk: The DALI Lifestyle Study. *The Journal of Clinical Endocrinology & Metabolism*. doi:10.1210/jc.2016-3455

35. Stafne, S. N., Salvesen, K. Å, Romundstad, P. R., Eggebø, T. M., Carlsen, S. M., & Mørkved, S. (2012). Regular Exercise During Pregnancy to Prevent Gestational Diabetes. *Obstetrics & Gynecology,119*(1), 29-36. doi:10.1097/aog.0b013e3182393f86

36. Sytsma, T. T., Zimmerman, K. P., Manning, J. B., Jenkins, S. M., Nelson, N. C., Clark, M. M., . . . Borowski, K. S. (2018). Perceived Barriers to Exercise in the First Trimester of Pregnancy. *The Journal of Perinatal Education,27*(4), 198-206. doi:10.1891/1058-1243.27.4.198

37. Wang, C., Wei, Y., Zhang, X., Zhang, Y., Xu, Q., Sun, Y., . . . Yang, H. (2017). A randomized clinical trial of exercise during pregnancy to prevent gestational diabetes mellitus and improve pregnancy outcome in overweight and obese pregnant women. *American Journal of Obstetrics and Gynecology,216*(4), 340-351. doi:10.1016/j.ajog.2017.01.037

38. Zhang, J. (1996). Exercise during pregnancy among US women. *Annals of Epidemiology,6*(1), 53-59. doi:10.1016/1047-2797(95)00093-3

Appendix A - Case Study

Case Study:

Jill is a 28-year-old female, 8 weeks pregnant. It is her first pregnancy and she decided to visit a Registered Dietitian Nutritionist to find ways to reduce her risk of developing gestational diabetes and promote a healthy pregnancy. She has a family history of Type 2 Diabetes. Her physician mentioned that she may be at a higher risk.

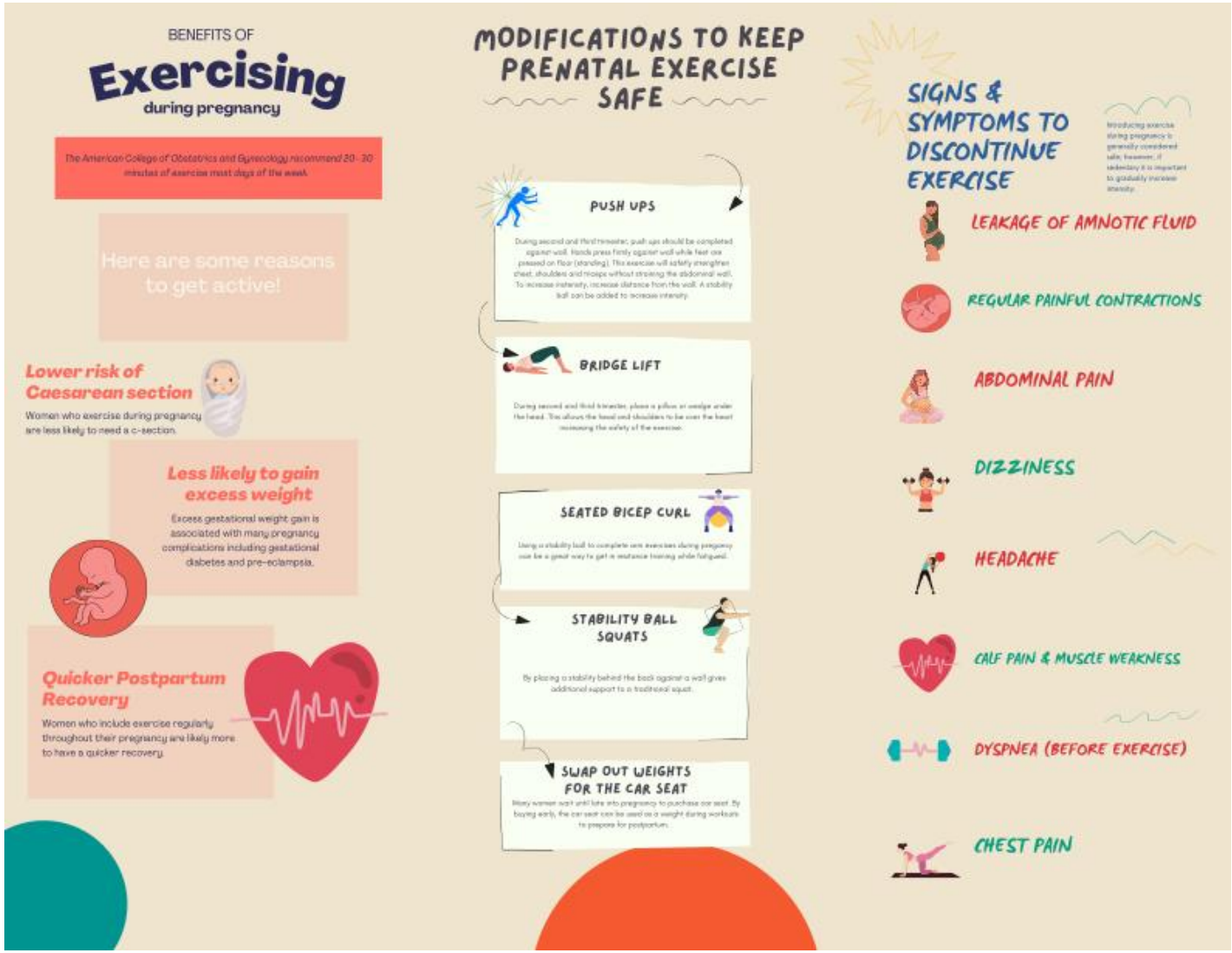
Jill's pre-pregnancy BMI was 27.5. She currently works an office job where she is sitting most of the day. Jill mentioned that she exercised prior to finding out she was pregnant. She said she was not sure if it was safe for her to continue exercising or if there was any benefit. Jill mentioned that she is excited to be pregnant and often reminds her husband that she is eating for two. In her food log, Jill reported eating a plain bagel for breakfast, a grilled chicken sandwich with French fries for lunch, and take-out chicken parmesan for dinner. She reported that she snacks often usually on candy, chips or on something that she is craving.

Recommended Treatment:

There are many options to reduce the risk of gestational diabetes. The first course of action is to help Jill understand how to best fuel her pregnancy. It is important to remind Jill that the calorie needs during pregnancy only increase 300-450 calories a day in the second and third trimester. A nourishing breakfast will likely help Jill control her blood glucose in the morning. By adding a vegetable omelet to her morning bagel, Jill can increase her protein, omega-3s and choline. Including fat, fiber and protein will help balance blood glucose and keep Jill on track. For her lunch and dinner, adding a side fruit or vegetable will increase nutrients, volume and fiber.

Based on her BMI, Jill should gain 15-25 lbs throughout her pregnancy. This can be done through both exercise and diet. The research completed in this literature review shows that exercise may be helpful for controlling weigh gain; however, alone, will not reduce her risk of developing gestational diabetes. Jill will benefit from learning that it is safe to exercise during pregnancy without contradictions. Educate Jill on potential modifications she can make to her normal exercise routine to make it comfortable and effective during pregnancy.

Appendix B – Resource



NOURISHING FOR TWO

CALORIE INTAKE

Trimester : No Increase
Trimester 2: Increase 340 calories/day
Trimester 3: Increase 450 calories/day

PROTEIN INTAKE

Protein needs increase by 25g/day!
To increase intake including greek yogurt to smoothies or try eating 6 small meals throughout the day.

WEIGHT GAIN GUIDELINES

Weight gain guidelines are based on pre-pregnancy BMI
Underweight: 28-40 lbs
Normal: 25-35 lbs
Overweight: 15-25 lbs
Obese: 11-20 lbs

FOOD FIRST FOR MICRONUTRIENTS

Eating a diverse diet allows for the body have access to a variety of micronutrients.

BE INFORMED ON FOOD SAFETY

Although pregnancy women are not at an increased risk of coming into contact with a food borne illness, they are more likely to have an adverse reaction.

Pregnancy is a great time to build healthier habits for both mother and child.

Nutrition & Exercise During Pregnancy