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Physical Activity and Sedentary Behavior During and After Pregnancy and Postpartum Weight Retention

Kaitlyn Taylor Ramey

PHYSICAL ACTIVITY AND SEDENTARY BEHAVIOR DURING AND AFTER PREGNANCY AND POSTPARTUM WEIGHT RETENTION

by

Kaitlyn Taylor Ramey

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Accepted by:

Abbi Lane-Cordova, Director of Thesis

Susan Yeargin, Reader

Shawn Arent, Reader

Tracey L. Weldon, Interim Vice Provost and Dean of the Graduate School

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ABSTRACT

INTRODUCTION AND PURPOSE

Pregnancy is associated with increased changes in body weight that can shape long-term health in women. Previous studies have shown that increased prenatal physical activity and decreased sedentary time correlated with less excessive gestational weight gain. Little is known about how leisure time exercise and sedentary behavior affects postpartum weight retention. The aim of our study was to identify how sedentary behavior and leisure time physical activity, both mid-pregnancy and after pregnancy, relate to postpartum weight retention from 6 months to 3 years after childbirth.

METHODS

A total of 79 women who delivered a singleton infant 6-months to 3-years ago were included in this study. Participants self-reported whether they lost the weight gained during pregnancy (yes/no). The mean age of women who had postpartum weight retention was 32 ± 1 years, and 33 ± 1 years for women who lost their weight gained during gestation. Participants also self-reported mid-pregnancy and current leisure time physical activity and sedentary behavior using validated questionnaires.

RESULTS

Of the participants who were sufficiently active during pregnancy and after pregnancy, sufficiently active at one time point, or insufficiently active at both time points, 64% (9/14), 40% (10/25), and 59% (22/37) of participants lost all the weight gained during pregnancy, respectively. There was no significant difference between the

three groups (p=0.22). For the participants who had high sedentary behavior at two time points, low sedentary behavior at one time point, and low sedentary behavior at two time points, 54% (14/26), 58% (11/19), and 50% (11/22) of participants lost all the weight, respectively. There was no significant difference between the three groups (p=0.88).

CONCLUSION

Women who performed a sufficient amount of exercise at both time points were not more likely to lose the weight gained during pregnancy. Based on our data, sedentary behavior during and after pregnancy do not seem to be associated with whether gestational weight gain is retained or lost post-pregnancy. Further research with larger sample sizes is recommended to establish the relationship between postpartum weight retention and longitudinal patterns in exercise and sedentary behavior, both during and post-pregnancy.

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LIST OF ABBREVIATIONS

BMI ..... Body Mass Index

BP ..... Blood Pressure

BSP ..... Brachial Systolic Pressure

DBP ..... Diastolic Blood Pressure

GDM ..... Gestational Diabetes Mellitus

GLTPAQ ..... Godin Leisure Time Physical Activity Questionnaire

Kg/m^2 ..... Kilograms per meter squared

Lbs ..... Pounds

mmHg ..... Millimeters of Mercury

SBP ..... Systolic Blood Pressure

SBQ ..... Sedentary Behavior Questionnaire

CHAPTER 1

LITERATURE REVIEW

1.1 RISING OBESITY RATES IN REPRODUCTIVE-AGED WOMEN

Pregnancy is an influential and life-changing milestone in a woman's life that shapes one's long-term cardiovascular health (Melzer, 2010). Obesity in the United States is on the rise, along with an increased number of women entering pregnancy with a higher body mass index (BMI) (Gilmore, 2015). This increase in BMI can lead to negative pregnancy outcomes, and these pregnancy outcomes can lead to long-term adverse events for the mother (Villamor, 2006). In people who are not pregnant, physiological, metabolic, and psychological factors are improved with regular exercise (Melzer, 2010). Even though there is a lack of literature on the topic, exercise seems to be beneficial for both the mother and fetus (Melzer, 2010). In order to understand the importance of increasing physical activity and reducing sedentary time in those who are pregnant, more research needs to be done.

1.2 PHYSICAL ACTIVITY AND SEDENTARY BEHAVIOR IN REPRODUCTIVE-AGED WOMEN

Habitual exercise is important to prevent morbidity and mortality (Pescatello, 2004). By increasing physical activity, the risk of developing several chronic diseases like type 2 diabetes, cancer, and cardiovascular diseases is reduced (Booth, 2012). One way exercise reduces chronic diseases is by maintaining blood pressure (Pescatello, 2004). However, increased physical activity is independent of decreased sedentary time.

While there is no quantification of how much sedentary time should be reduced, it is recommended that sedentary time is reduced across all age groups (Bull, 2020). This is because increased sedentary time bad for our cardiovascular health (Lavie, 2019). For reproductive aged women, exercising while pregnant has been previously discouraged with the fear that it would overload the mother's heart and reduce metabolic factors in the placenta (Veille, 1992). But current research has observed that approximately 60% of women during pregnancy took part in sedentary behavior for 10 hours per day, approximately two-thirds of their waking time, and that this increased sedentary time was associated with an increased odds of adverse pregnancy outcomes (Barone Gibbs, 2021).

1.3 PRENATAL AND POSTPARTUM PHYSICAL ACTIVITY: RECOMMENDATIONS AND EVIDENCE FOR BENEFITS OF PHYSICAL ACTIVITY DURING PREGNANCY

According to the 2018 Physical Activity Guidelines Advisory Committee, an adult should perform 150 to 300 minutes of moderate-intensity, or 75 to 150 minutes of vigorous-intensity aerobic physical activity a week (Piercy, 2018). In addition, strength training exercises should be performed twice a week (Piercy, 2018). For women who are pregnant, it is recommended by the American College of Obstetricians and Gynecologists that these women perform 20 to 30 minutes of moderate intensity exercise per day, four to seven days of the week ("Physical Activity and Exercise," 2020). In general, women who enter pregnancy with a healthy lifestyle are strongly encouraged to continue those habits ("Physical Activity and Exercise," 2020). Exercise during pregnancy is very beneficial to the mother and the child, even though some exercise modifications may be necessary (Melzer, 2010). Before recommending an exercise

program, pregnant individuals should go through a thorough clinical evaluation to ensure there are no medical reasons to withhold exercise ("Physical Activity and Exercise," 2020). The benefits of exercise during pregnancy, as observed in previous studies, include decreased gestational diabetes mellitus (GDM), cesarean birth, and postpartum recovery time ("Physical Activity and Exercise," 2020).

1.4 PREGNANCY SHAPES LONG-TERM MATERNAL HEALTH

Throughout pregnancy, there are constant changes in the female body including metabolism, skeletal and bone density, endocrine, respiratory, vascular, hematologic, and cardiac changes (Soma-Pillay, 2016). There is an increase in cardiac demand at rest, resulting from increased metabolic requirements and hemodynamic alterations (Meah, 2016). There is also an increase in weight as the baby forms inside the mother; this increase in weight during pregnancy is called gestational weight gain. The Institute of Medicine has created a chart of recommended weight gain during pregnancy based on pre-pregnancy BMI (Rasmussen, 2009). For individuals who are underweight, or have a BMI of less than 18.5 kg/m^2, they should gain 28 to 40 pounds during pregnancy (Rasmussen, 2009). For normal weight individuals (BMI of 18.5-24.9 kg/m^2), 25-35 pounds should be gained (Rasmussen, 2009). Individuals who are overweight (BMI 25-29 kg/m^2) or obese (BMI of 30 kg/m^2 or greater) should gain 15-25 pounds and 11-20 pounds, respectively (Rasmussen, 2009). Adverse pregnancy outcomes including high birth weight, large for gestation age, hypertension, gestational diabetes, delivery and labor complications, and postpartum weight retention can also be a result of excessive gestational weight gain (Haugen, 2014).

Adverse pregnancy outcomes include pregnancy associated hypertension, pre-eclampsia, GDM, low birth weight, and preterm birth. Gestational hypertension is when women have high blood pressure after the 20th week of pregnancy. Pre-eclampsia also includes hypertension after the 20th week of pregnancy, but for this diagnosis, there is excess protein in the urine. Pre-eclampsia poses a very high risk of organ damage, and even fatal outcomes for the mother and baby if not treated properly. Chronic hypertension is when an individual's systolic blood pressure (SBP) is greater than 130 mmHg and/or diastolic blood pressure is greater than 80 mmHg (Whelton, 2017). This form of hypertension is diagnosed before pregnancy or before the 20th week of gestation. GDM is caused by an increase in blood glucose that cannot be managed by insulin due to hormones produced by the placenta. Rather than having a lack of insulin like regular diabetes mellitus, other hormones produced in the body during pregnancy make the insulin less effective. Low birth weight is when a newborn baby is less than 5 pounds 8 ounces. Preterm birth is when a baby is born before 37 weeks of gestation.

After birth, it is important to reduce postpartum weight retention to reduce the risk of obesity. If one exceeds these gestational weight gain guidelines, along with retaining the weight after delivery, this causes a risk for coronary artery disease, ischemic stroke, type 2 diabetes mellitus, osteoarthritis, and some forms of cancer (Chescheir, 2011). Risk factors for postpartum weight retention include lower income, young age, high pre-pregnancy BMI, excessive weight gain during pregnancy, not breastfeeding, and not reaching required exercise goals postpartum (Endres, 2015). Postpartum weight retention significantly increases the likelihood of obesity in the mother 1 year after delivery, even for women who enter pregnancy at a normal weight (Endres, 2015). Therefore, it is

important to resume physical activity as soon as possible and in a comfortable and manageable manner to reduce the risk of obesity and other negative postpartum outcomes. Data collected from 11 randomized controlled trials suggested that post-partum weight retention was lower in groups that performed exercise versus those who did not (Ruchat, 2018). Another previous study has displayed that an increase in postpartum physical activity is associated with a reduction in weight retention 6 months to 12 months postpartum (Ha, 2020).

CHAPTER 2

AIMS AND HYPOTHESES

The aim of this study was to identify how sedentary behavior and leisure time physical activity, both mid-pregnancy and after pregnancy, relate to postpartum weight retention from 6 months to 3 years after childbirth. It was hypothesized that women who are sufficiently active mid-pregnancy and post-pregnancy will be more likely to lose their gestational weight gained versus those who were insufficiently active at one time point or both time points. Our second hypothesis was that women who had more sedentary behavior and insufficient physical activity will be more likely to have postpartum weight retention.

CHAPTER 3

METHODS

3.1 STUDY DESIGN

The data presented in this paper is data collected from a larger case-control study assessing cardiovascular function in women with and without adverse pregnancy outcomes. The participants were recruited from the community by word of mouth, hanging fliers in the surrounding areas, and posting on online forums created for mothers of the community. After recruitment, the participants were called and screened by a graduate research assistant. If eligible, participants were asked to come to the lab for 1 visit to assess cardiovascular function. During the lab visit, participants were asked to fill out the following questionnaires: demographic data, Godin Leisure Time Physical Activity Questionnaire (Amireault, 2015), and Sedentary Behavior Questionnaire (Rosenberg, 2010). Demographic data, such as age, race/ethnicity, years of schooling, marital status, employment status, medical history, number of pregnancies, gestational weight gained, and if the gestational weight was lost post-pregnancy, were self-reported.

3.2 PARTICIPANTS

Participants who were older than 18 years and delivered a singleton infant 6 months to 3 years ago were recruited for the study. If the individuals smoked, used steroids or proteasome inhibitors, had type 1 diabetes, type 2 diabetes, or cancer, they were excluded from the study.

3.3 PHYSICAL ACTIVITY

The participants filled out two Godin Leisure Time Physical Activity questionnaires (Amireault, 2015). The Godin Leisure Time Physical Activity Questionnaire (GLTPAQ) that is used in this study is an excerpt of the reliable and valid measure of leisure time physical activity (Amireault, 2015). This questionnaire consists of four, self-explanatory items indicating how many times per week an individual takes part in strenuous, moderate, or mild exercise for more than 15 minutes and how often they engage in any regular activity long enough to work up a sweat (Amireault, 2015). One questionnaire was used to recall their leisure time physical activity during the mid-point of their pregnancy, while the second questionnaire was used to report their current leisure time physical activity at the time of the lab visit. These were our two time points used in our analyses. We used pre-determined cut-off points to define women as sufficiently active at both time points, sufficiently active at one time point, or insufficiently active at both time points, according to National Physical Activity Guidelines (Amireault, 2015). If participants had a leisure score index (LSI) of ≥ 24, they were classified as sufficiently active, and an LSI ≤ 23 were classified as insufficiently active (Amireault, 2015).

3.4 SEDENTARY BEHAVIOR

The Sedentary Behavior Questionnaire (SBQ) is a reliable and valid questionnaire consisting of 18 questions in total, 9 of which are answered for sedentary behavior during the weekdays and the other 9 for the weekend days (Rosenberg, 2010). The questions ask how much time one spends watching television, playing computer or video games, sitting listening to music, sitting and talking on the phone, doing paperwork or computer work, sitting reading a book or magazine, playing a musical instrument, doing artwork or crafts,

and sitting and driving in a car, bus, or train (Rosenberg, 2010). We established cut-off points for the sedentary behavior questionnaire by finding the median, as there are no established cut-off points for high sedentary behavior. Individuals with values above the median of 8.5 hours were deemed as having high sedentary behavior and values below 8.5 hours were deemed as having low sedentary behavior. Women were then categorized as having high sedentary behavior at both time points, low sedentary behavior at one time point, or low sedentary behavior at both time points.

3.4 COVARIATES

Covariates in our analyses included age, race/ethnicity, years of schooling, BMI, marital status, employment status, medical history, number of pregnancies, and blood pressure. BMI was calculated by using the equation BMI = kg/m^2. A digital scale was used to measure weight in kilograms and a stadiometer to measure height in centimeters. Brachial blood pressure was assessed by lying in a supine position and using an automated oscillometric cuff (HEM-907 XL; Omron). This measure was taken twice, one minute apart. If two consecutive blood pressure ranges were within 5 mmHg, the average of the two values were calculated and recorded. The other covariates were measured by a self-reported demographic questionnaire.

3.5 STATISTICAL ANALYSES

For statistical analyses, a p-value of $p \leq 0.05$ was set for statistical significance. A Shapiro-Wilks test was done to assess normality of the data. For normal data, a t-test was used to determine a difference in means. For data that is not normally distributed, a Wilcoxon Rank-Sum test was used. A χ^2 test was used to determine the likelihood of not retaining pregnancy weight between sufficient physical activity levels. A χ^2 test was also

used to determine the likelihood of losing the weight gained during gestation between those with sedentary behavior above or below the median.

CHAPTER 4

RESULTS

4.1 STUDY PARTICIPANTS

There was a total of 79 participants who met eligibility criteria and attended a lab visit. The mean age of women who did not lose the weight gained during gestation was 32 ± 1 years, with a BMI of 29.6 ± 1.2 kg/m^2, a brachial systolic pressure (BSP) of 110 ± 2 mmHg, and a brachial diastolic pressure (BDP) of 69 ± 2 mmHg (Table 4.1). The mean age of women who lost their weight gained during gestation was 33 ± 1 years, with a BMI of 27.9 ± 1.4 kg/m^2, a BSP of 113 ± 2 mmHg, and a BDP of 73 ± 2 mmHg (Table 4.1). Of the women who had postpartum weight retention and who had lost their weight gained during gestation, there was a mean weight gain 31.2 ± 4.0lbs and 28.0 ± 2.8lbs during pregnancy, respectively (Table 4.1).

4.2 PHYSICAL ACTIVITY AND SEDENTARY BEHAVIOR

Of the participants included in the study, 76 participants filled out the GLTPAQ and 70 filled out the SBQ. Out of the 76 participants who filled out the GLTPAQ, 18% (14/76) were insufficiently active at both time points, 33% (25/76) were sufficiently active at one time point, and 49% (37/76) were sufficiently active at both time points. Of the women that were insufficiently active at both time points, 64% (9/14) lost the weight. Of the women that were sufficiently active at one time point, and at both time points, 40% (10/25) and 59% (22/37) lost the weight, respectively (Figure 4.1). The difference in

proportion of people who lost the weight and physical activity was not statistically significant, with a p-value of p=0.22.

Out of the 70 participants who filled out the SBQ, 40% (28/70) had high sedentary behavior at both time points, 27% (19/70) had low sedentary behavior at one time point, and 33% (23/70) had low sedentary behavior at both time points. Of the women that had high sedentary behavior at both time points, 54% (14/26) lost the weight. Of the women that had low sedentary behavior at one time point and at both time points, 58% (11/19) and 50% (11/22) lost the weight gained during pregnancy, respectively (Figure 4.2). No significance at the $p \leq 0.05$ level for difference in proportion of people who lost weight by sedentary behavior, with a p-value of p=0.88. When comparing sedentary time, physical activity, BMI, and age to losing the gestational weight gained during pregnancy, it was not statistically significant.

Table 4.1. Demographics of participants who did versus did not lose the weight gained during gestation.

Demographics	**Did NOT lose all the weight**	**DID lose all the weight**
Age (years)	32 ± 1	33 ± 1
BMI (kg/m^2)	29.6 ± 1.2	27.9 ± 1.4
BSP (mmHg)	110 ± 2	113 ± 2
BDP (mmHg)	69 ± 2	73 ± 2
Weight gained (lbs)	31.2 ± 4.0	28.0 ± 2.8
Pregnancy Weekday LSI	28 ± 4	34 ± 4
Current Weekday LSI	38 ± 4	41 ± 4

Table legend. The values shown here are represented by the mean ± standard error. Age: measured in years; BMI: body mass index; BSP: brachial systolic pressure; BDP: brachial diastolic pressure; LSI: leisure score indexes calculated from the Godin Leisure Time Physical Activity Questionnaire.

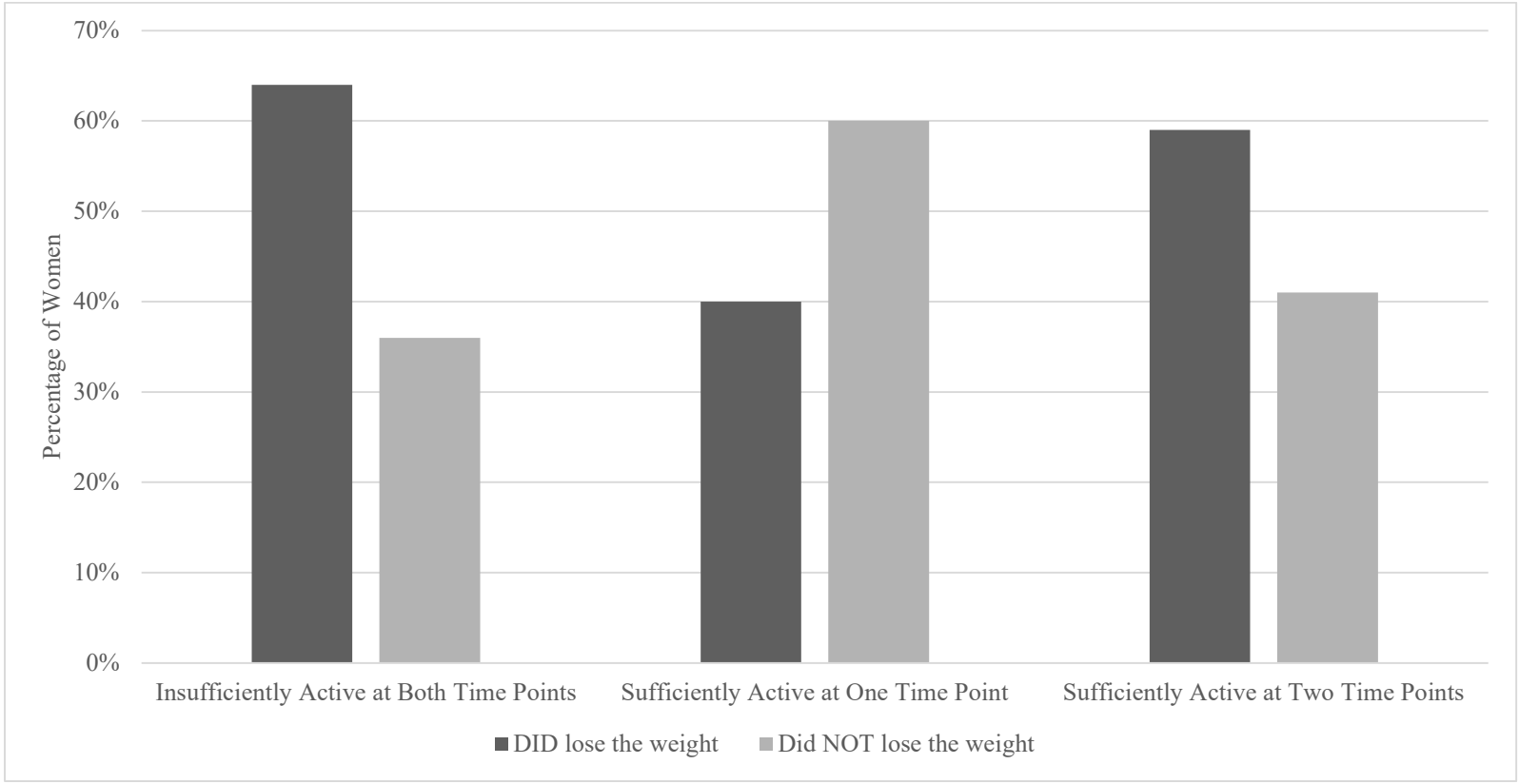

Figure 4.1. Percentage of women who did and did not lose the weight gained during pregnancy per each physical activity group. n=14 insufficiently active at both time points, n=25 sufficiently active at one time point, n=37 sufficiently active at two time points. Time points for each category were during pregnancy (recalled physical activity) and post-pregnancy (current physical activity).

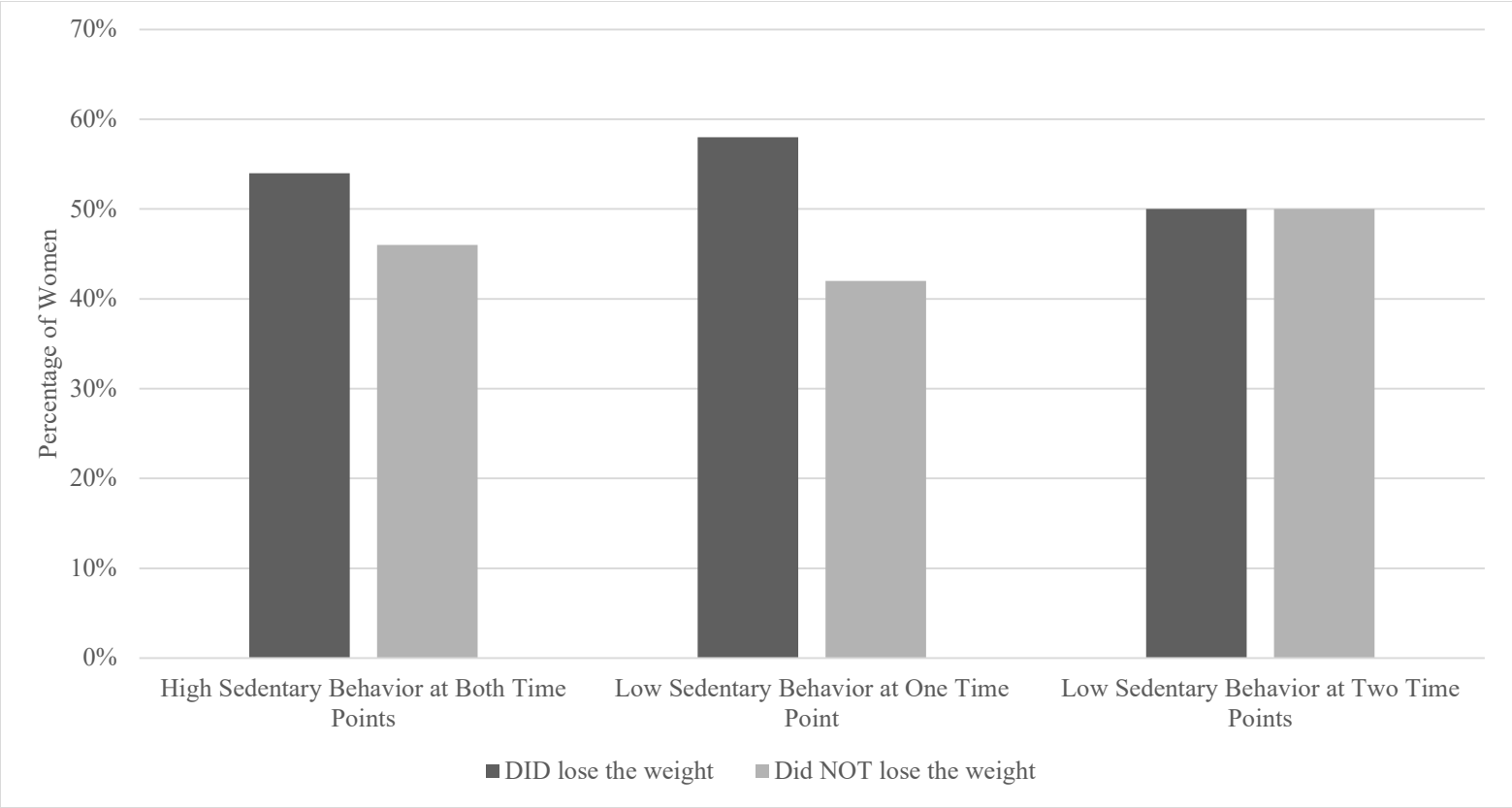

Figure 4.2. Percentage of women who did and did not lose the weight gained during pregnancy per each sedentary behavior group. n=28 high sedentary behavior at both time points, n=19 low sedentary behavior at one time point, n=23 low sedentary behavior at two time points. Time points for each category were during pregnancy (recalled sedentary behavior) and post-pregnancy (current sedentary behavior).

CHAPTER 5

DISCUSSION

5.1 MAIN FINDINGS AND OUTCOMES

The aim of this study was to identify how sedentary behavior and leisure time physical activity, both mid-pregnancy and after pregnancy, relates to postpartum weight retention from 6 months to 3 years after childbirth. It is observed that women who performed a sufficient amount of exercise at both time points were not more likely to lose the weight gained during pregnancy. The mean BMI for participants who lost their weight gained during gestation was 27.9 ± 1.4 kg/m^2, which is in the overweight category. For participants who had postpartum weight retention, they had a mean BMI of 29.6 ± 1.2 kg/m^2. These individuals are in the overweight category as well, but are nearing the obese category that is classified as a BMI greater than or equal to 30 kg/m^2. Of the participants in both categories, blood pressure was in the normotensive ranges. For both categories, the weight gained during pregnancy falls within the recommended ranges for normal weight individuals but exceeds the recommended weight gain for overweight or obese individuals, which is 15 to 25lbs and 11 to 20lbs, respectively (Rasmussen, 2009).

The participants who did and did not lose their weight gained during gestation had similar mean weekday and weekend LSI, both mid-pregnancy and post-pregnancy. The likelihood of not retaining the weight gained during gestation and physical activity level was not statistically significant ($p=0.22$). The LSI means for both groups at both time

points were greater than 24, classifying both group means as sufficiently active. Because the means of both groups were classified as sufficiently active, this could be a reason why values did not reach statistical significance when comparing physical activity and postpartum gestational weight loss.

Based on this preliminary data, measuring sedentary behavior during and after pregnancy do not seem to be associated with whether gestational weight gain is retained or lost post-pregnancy. This could also be due to the cut-off points we established to determine high sedentary behavior and low sedentary behavior. The median time was 8.5 hours; those who had less than 8.5 hours per day were considered having low sedentary behavior and about 8.5 hours were considered having high sedentary behavior. Even if the participants had low sedentary behavior, it still could be an excess amount of sedentary time each day. It is known that an increase in overweight and obesity is partly due to an increase in sedentary time and a decrease in physical activity. While we know that increased sedentary time is bad for our cardiovascular health (Lavie, 2019), there are no formal recommendations around sedentary time aside from breaking up long sedentary bouts with physical activity (Bull, 2020). A previous study observed that higher sedentary behavior was associated with an increased odds of adverse pregnancy outcomes (Barone Gibbs, 2021). Therefore, sedentary behavior should be studied further in order to understand how sedentary behavior affects postpartum weight retention.

With the exaggerated effect of hypertension, more than half the deaths in the United States are from heart disease, stroke, and renal failure (Ezzati, 2002). Therefore, it is of great importance that blood pressure be managed to protect the quality of life of every individual (Pescatello, 2004). The normal blood pressure range for adults is a SBP

of 120mmHg and a DBP of 80mmHg (Whelton, 2018). If SBP is above 130 mmHg and DBP is above 80mmHg, this is considered high blood pressure, or hypertension (Whelton, 2018). There are many diseases associated with and caused by hypertension, including cardiovascular disease, stroke, coronary artery disease, heart failure, peripheral arterial disease, and renal insufficiency (Pescatello, 2004). Previous studies have established that exercise can reduce blood pressure in healthy (Cornelissen, 2013) and hypertensive individuals (Börjesson, 2016). A meta-analysis analyzed 27 randomized controlled studies and reported that medium to high intensity aerobic activity has the possibility of reducing blood pressure in individuals with hypertension by 11/5 mmHg (Börjesson, 2016). Since exercise reduces chronic diseases by maintaining blood pressure (Pescatello, 2004), studying physical activity during pregnancy and post pregnancy is important in the potential reduction of postpartum weight retention and chronic disease.

5.2 LIMITATIONS

Limitations to this study include having the participants fill out multiple questionnaires. The participants had to recall their mid-pregnancy physical activity and sedentary behavior, along with how much weight they gained during their pregnancy. While participants would be able to recall current physical activity and sedentary behavior, having them recall these values for the mid-point of their pregnancy could lead to inaccurate results. The questionnaires used are proven to be reliable and valid, but self-reported and recall measures tend to lead to biased estimates and a decrease in internal validity (Althubaiti, 2016). This is the same for recalling whether gestational weight gained during pregnancy was lost. This question was a yes or no question, allowing the participant to answer from memory and without providing evidence. In addition to recall

bias, the GLTPAQ establishes their cutoff points based on current physical activity recommendations (Amireault, 2015). These recommendations, however, are based on physical activity needed to maintain an individual's current weight. It is determined that more physical activity needs to be performed in order to see weight loss (Centers for Disease Control and Prevention, 2020).

We also do not know the participants' weight and BMI before pregnancy. By only having two time points that do not include pre-pregnancy values, we were unable to observe if women returned to their pre-pregnancy physical activity, weight, and BMI. Another limitation to this study is the lack of caloric data. In order to study weight changes, caloric intake in addition to physical activity is essential. This would help us understand calories in versus calories out. In addition, our small population may have been statistically underpowered, causing inaccurate findings and the inability to anticipate the effect of leisure time physical activity and sedentary behavior on postpartum weight retention.

5.3 FUTURE DIRECTIONS

There are methods to improve on when developing future studies. Instead of being a case-control study with data collected at one time point, future studies should consider a longitudinal, observational study with multiple time points. Pre-pregnancy data would be ideal, but early pregnancy BMI has been shown to be highly correlated with pre-pregnancy BMI (Catov, 2018). Having a time point very close to the beginning of pregnancy, late pregnancy, and postpartum would help give us a better understanding of participants weight gain during pregnancy versus weight loss after pregnancy. Data collected could also include objectively measuring physical activity and sedentary

behavior with accelerometry, in addition to the GLTPAQ and SBQ. Adding a questionnaire or food log to understand participants dietary habits would be beneficial as well. This data would have the potential to compare objective and subjective data on physical activity and caloric intake to better understand physical activity, sedentary behavior, and postpartum weight retention. Having pre-pregnancy or early pregnancy values will help us better understand if the participants were able to return their pre-pregnancy values. Being able to objectively quantify sedentary behavior will be useful in understanding and producing recommendations in conjunction with the physical activity recommendations already in place.

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