A Walking Plan for Pregnant Women with Gestational Diabetes: A Feasibility Study

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Gestational diabetes mellitus (GDM) is a well-established predictor for the development of type II diabetes mellitus (T2DM) later in life. The incidence of GDM has been on the rise over the past 30 years and is the leading co-morbidity during pregnancy (Ferrara, 2007). Physical activity (PA) in combination with nutritional therapy has been shown to achieve glycemic control in women with GDM and is therefore first line therapy for management (American College of Obstetrics and Gynecology [ACOG], 2017; Center for Disease Control and Prevent [CDC], 2018). Recommendations for PA in pregnancy include 150 minutes of moderate intensity exercise most days of the week (ACOG 2015; U.S. Department of Health & Human Services, 2018). Because of this, an innovative project was created to determine the feasibility of adding a walking plan into GDM care. Participants in the project received verbal and written instruction on an unsupervised structured walking plan set up for a beginner to gradually increase PA to the recommended time of 150 minutes per week for a total of four weeks. Eight women were interested, recruited, and enrolled in the project. Results show that overall, participant PA increased. One hundred percent agreed that the walking plan was useful and increased their awareness about PA. The addition of a walking plan in GDM teaching is an effective strategy to lower serum blood glucose (SBG) levels and for meeting PA recommendations during pregnancy.

Keywords: gestational diabetes mellitus, physical activity, walking

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Gestational diabetes mellitus (GDM), is on the rise globally, affecting seven percent of all pregnancies. There is a greater prevalence of GDM among women of reproductive age, particularly women who are obese and have a sedentary lifestyle (ACOG, 2018). First line therapy for controlling GDM includes nutrition and exercise counseling (ACOG, 2018). Participation in physical activity (PA) is low among women with GDM (Harrison, Shields, Taylor, & Frawley, 2016).

Background and Significance

Diabetes in pregnancy is a condition characterized by serum blood glucose (SBG) levels that are associated with a higher risk for adverse outcomes for mother and fetus in an affected pregnancy. Insulin is the main component that controls the amount of glucose in an individual's blood. Insulin resistance is an expected change in pregnancy and each individual pregnancy varies in the level of insulin resistance (Kaaja & Ronnemaa, 2008). In those women whose resistance to the glucose controlling function of insulin is higher than expected, their SBG levels rise to a level that is potentially harmful to the woman herself and her unborn child.

Diabetes is the most common co-morbid condition during pregnancy (American College of Obstetricians and Gynecologist [ACOG], 2018). There are several classifications of diabetes that can complicate a pregnancy, such as GDM, type II diabetes mellitus (T2DM), and type I diabetes mellitus (T1DM). Maternal complications of diabetes in pregnancy include higher risk of developing preeclampsia, higher incidence of undergoing a cesarean delivery, and the development of T2DM later in life. Fetal complications of diabetes in pregnancy include risk for

macrosomia, neonatal hypoglycemia, hyperbilirubinemia, shoulder dystocia, and birth trauma (ACOG, 2018).

First line therapy for controlling high SBG levels in pregnancy include lifestyle modifications and nutritional therapy (Centers for Disease Control and Prevention [CDC], 2018). Nutritional therapy in combination with PA has been shown to achieve glycemic control (ACOG, 2015). Aerobic exercise that activates large muscles such as quadriceps, stimulates glucose uptake in muscles, increases energy, and improves glucose transportation, which can result in improved glycemic control (Harrison et al., 2016).   Recommendations for PA in pregnancy include 150 minutes of moderate intensity exercise spread out over the week that is adjusted as necessary (ACOG 2015; U.S. Department of Health & Human Services, 2018). For women with an uncomplicated pregnancy, and pregnant women with diabetes whose SBG levels are controlled, PA is safe.

There is empirical evidence to support the benefit of PA in pregnancy. ACOG (2015) recommends that women should be encouraged to continue or initiate exercise during pregnancy with guidelines. Despite the profound anatomic and physiologic changes associated with pregnancy, the risks of moderate intensity PA performed by women during pregnancy, where exercise is not contraindicated, are low and do not appear to increase the risk of low birth weight infants, preterm delivery, or early miscarriage (ACOG, 2015).

Walking is a common and popular PA choice during pregnancy because of its high accessibility. Walking at a brisk pace has been shown to reduce SBG levels, preeclampsia, and excessive gestational weight gain (Kim & Chung, 2015). In a study conducted in 2014, an unsupervised walking program increased moderate intensity activity in overweight and obese pregnant women (Kong, Campbell, Foster, Peterson, & Lanningham-Foster, 2014). In another

study that focused on a walking program for women with GDM, lower SBG levels were achieved and women who were previously sedentary, overweight, or obese were able to successfully follow the moderate intensity-walking program (Davenport, Mottola, McManus, & Gratton, 2008).

Internal Evidence

In a maternal fetal medicine office in the Southwestern United States, there is no standard curriculum to address PA in new or continued GDM teaching and care. Women diagnosed with GDM receive education from a certified diabetes educator. During the initial hour-long education session given to newly diagnosed pregnant women with GDM, extensive education is provided which focuses on diet control and carbohydrate counting. PA is only briefly mentioned during this visit and rarely addressed at follow-up visits.

<p align="center">**Problem Statement**</p>

The prevalence of GDM is as high as 9.2% in American women (American Diabetes Association [ADA], 2016). Locally, the prevalence of GDM in Arizona is between 3 to 8% with a higher prevalence in African American, Latino/Hispanic, and American Indian women (Arizona Department of Health Services Bureau of Tobacco and Chronic Diseases, 2018). GDM is a well-established predictor for the development of T2DM later in life (Noctor & Dunne, 2015). In 2017, the national economic burden of diagnosed diabetes was estimated at approximately $327 billion, a 26% increase in the past 5 years (ADA, 2018). Because of the global burden of T2DM, preventing the progression to T2DM in high risk populations is essential.

There are different ways to treat GDM, including lifestyle modifications followed by medication treatment. Lifestyle modifications include diet adjustment and PA, whereas

medication treatment includes subcutaneous insulin as well as oral agents. Empirical evidence supports the benefit of PA in pregnancy, which can lower SBG levels. For example, walking after dinner can naturally lowering postprandial SBG levels (DiPietro, Gribok, Stevens, Hamm, & Rumpler, 2013). Naturally lowering postprandial SBGs levels could lead to a decrease in need for oral agents and subcutaneous insulin needs, which in turn can decrease healthcare costs.

The national recommendation for PA in pregnancy is 150 minutes per week (ACOG 2015; U.S. Department of Health & Human Services, 2018). This time can be broken up throughout the week and even the day. Moderate intensity aerobic activity includes but not limited to brisk walking, swimming, or actively playing with children. With no formal PA education established in GDM care, the project site is missing an opportunity to align with the national recommendations of PA, and to build upon their current GDM care.

PICOT Question

In women with GDM, how does PA compared to sedentary behavior affect postprandial SBG levels?

<div align="center">**Search Strategy**</div>

Databases used in the search process included Cumulative Index of Nursing and Allied Health Literature (CINAHL), PubMed, and The Cochrane Library. Keywords used included gestational diabetes, GDM, exercise, physical activity, postprandial blood sugar, glycemic control, and outcomes. Limits set on the search included publications dated between 2013-2018. The CINAHL search revealed 264 articles using the keywords, physical activity and gestational diabetes. The PubMed search revealed 278 results with the publication date limitation and the keywords of gestational diabetes, physical activity, and outcomes. The Cochrane Library search

revealed a smaller number of results with 6 out of 10, 067 articles with the keywords gestational

diabetes and physical activity.

Exclusion criteria included a published date of before 2013 except for one landmark

study from 2010. Other exclusion criteria included studies about pre-existing diabetes and on the

prevention of GDM.

After critical appraisal of 30 studies, 10 were chosen to be included in an exhaustive

literature review. Excluded studies provided unclear conclusions, no data for research conducted,

or were impertinent to the review. Studies included evaluated the use of lifestyle modifications

such as PA compared to sedentary behavior, its effect on glycemic control, and pregnancy

outcomes for women with GDM. Other databases searched related to GDM included ACOG,

CDC, and the ADA. These resources were used as clinical practice guidelines.

Evidence Synthesis

Ten studies were evaluated using the rapid critical appraisal approach. The strength of the

studies had a high level of evidence. Seven of the studies were systematic reviews for level one

evidence; and the remaining were randomized control trials (RCT) for level two evidence. Most

of the studies noted level of significance, effect size, and standard deviations. The sample size of

the RCT's ranged from as low as 38 participants to as high as 1,083 participants. Mostly large

sample sizes were used in the controlled groups with all studies evaluating some form of PA. All

articles required a medical diagnosis of GDM.

Reliability and validity of the evidence is evaluated through the outcome evaluation and

the production of statistically significant data. All studies implemented interventions on

individuals with GDM through the lifestyle modification of PA. All studies identified substantial

outcomes through production significance levels. No bias were identified throughout the studies,

although sampling bias could be indicated for studies completed in other countries because it

does not include women of other ethnic groups.

A high degree of homogeneity was identified among all studies related to age and gender.

All study participants were women of reproductive age with a mean age of 31 to 32 years old.

All but one study measured capillary fasting SBG levels, and seven studies measured

postprandial SBG levels.

The degree of heterogeneity came from the differences in population demographics. All

but two studies were performed in other countries other than the United States such as Asia,

Australia, and India. Although all studies included the intervention of PA amongst women with

GDM, all studies did not follow the same exercise routine. There were a variety of types of PA

tested including resistance training, walking, and yoga (See Appendix A).

Purpose Statement

Based on the evidence, the specific aim of this one group pre-test posttest design is to

determine the feasibility of a practice recommending that a walking plan for pregnant women

diagnosed with GDM is appropriate for further research. This intervention provides an

opportunity to naturally lower SBG levels through the use of a highly accessible PA choice. The

stakeholders who will benefit from this intervention are the GDM individuals, healthcare

providers, as well as the practice. If this intervention is implemented in multiple practice

locations, there could be a positive change in standardizing comprehensive GDM care.

Theoretical Model

The Theory of Planned Behavior (TPB) conceptual framework (See Appendix B) works

by predicting an individual's intention to engage in a behavior (Ajzen, 1985). This model focuses

on a person's intention and attitude toward a behavior change. The TPB framework was chosen

for this intervention to motivate women with GDM to participate in PA by making a lifestyle modification change. The main component of the TPB framework is behavioral intentions influenced by the attitude of the subject about the likelihood that this behavior change will have the expected outcome and the subjective evaluation of that outcome (Ajzen, 1985).

The TPB framework is based on six constructs that represent the person's control over the behavior. First is attitude, this is referring to the individual's perception of the behavior of interest. In this project, the individual needs to consider the outcomes of performing walking. Second is behavioral intention, this refers to the motivational factors for the participant to complete the behavior. For this project, this is the motivation to participate in PA. Third is subjective norms, this refers to the way that others perceive the behavior change, it relates to the individual's beliefs about whether their peers, significant others, or healthcare provider's beliefs related to the importance of engaging in the walking plan. Fourth is social norms, this refers to customary codes of behavior and what is considered normal for this behavior. For this project, that includes the individual's perception of walking and if it is socially acceptable. Fifth is perceived power, this is related to perceived factors that may impede or facilitate performance of the behavior. In this project, this could include pregnancy or other factors that would keep the individual from completing walking. Sixth is perceived behavioral control, this refers to the person's perception of the difficulty of the planned behavior change. For this project, this includes how the patient feels about walking and if they will continue to stay physically active (Ajzen, 1985).

Evidence Based Practice Model

The Iowa Model of Evidence Based Practice to Promote Quality Care (See Appendix C) is used to facilitate this project. This model provides a step-by-step guide on how to recognize a

clinical problem and match it with an intervention based on research to make a practice change

(Titler et al., 2001). There is a sufficient research base with high levels of evidence, therefore it

is appropriate to pilot a change into practice. For this project, outcomes to be achieved included

participant satisfaction, uptake of PA, and knowledge about the benefits of PA in pregnancies

complicated by GDM. Baseline data was collected, and the intervention was piloted into one

practice location. The outcomes were then evaluated for a future practice change to include a

walking plan into GDM care.

Project Methods

Pre-Intervention

Human subject protection was obtained from Arizona State University's Institutional

Review Board before the project began. Participants were recruited for the project using a

recruitment flyer located at the project site. The recruitment flyer briefly explains the project,

expectations, relevant inclusion criteria, contact information to participate, and explains that

participation is voluntary. Potential participants were only identified and recruited during the

recruitment phase of the project.

Potential participants that were interested in the project, were screened for project

qualification using the PARmed-X for Pregnancy. The PARmed-X for Pregnancy is a validated

tool that provides medical clearance for pregnant individuals to initiate prenatal exercise

programs (Canadian Society for Exercise Physiology, 2015). It has been used in multiple studies

in the literature as a medical clearance tool (Canadian Society for Exercise Physiology, 2015).

The checklist includes the absolute and relative contraindications to exercise in pregnancy that is

consistent with ACOG's criteria (See Appendix D). Permission to use the PARmed-X for

Pregnancy was obtained from the authors before use. Medical eligibility was ultimately

determined from the participant's healthcare provider. The healthcare providers were blind to the project participants because they were not informed if the interested participant chose to participate in the project or not. The co-investigator had access to the potential participant's medical records through the electronic health record (EHR) to collect information for the PARmed-X for Pregnancy. Potential participants consented to this on the eligibility consent form.

Screening for project inclusion took place outside of the participant's healthcare provider visit and in a separate space. Enrollment took place after their initial GDM visit for project pre-data to include a minimum of one week of SBG values before participants started in the project. Participants that qualified for project inclusion and were interested in participating signed the consent form. Inclusion criteria for the project were females with a singleton pregnancy, over the age of 18, less than 34 weeks gestations, and had a diagnosis of GDM. After the consent form was signed, confidential participant information was manually entered onto the identity key by the co-investigator. The identity key was kept in its own file in a locked cabinet at the project site that only the co-investigator had access to.

Intervention

Participants in the project received verbal and written instruction on an unsupervised walking plan for the beginner that was set up to gradually increase PA to the recommended time of 150 minutes per week (See Appendix E). The walking plan was based on the U.S. Department of Health and Human Services (2018) and ACOG's (2015) guidelines for PA in pregnancy and follows a gradual progression of PA for women who were sedentary before pregnancy. Face validity for the walking plan was achieved. Participants were given a paper log to track their PA time and exertion level in addition to tracking their SBG levels four times daily (See Appendix

F). This log was already in current use at the project site. Participants in this project already had

received education and training regarding their diabetes in pregnancy and were already checking

their SBG levels four times a day for at least one week prior to beginning the walking plan.

Participants were given verbal and written instruction on PA exertion levels and warning signs to

discontinue PA while pregnant based on ACOG guidelines. Participants already had an

established phone number and a hospital available 24 hours a day for any pregnancy-related

concerns. The instruction took place at the project site in a separate room from any health care

provider.

Post-Intervention

After four weeks from the project start date, participants received a feedback survey via

email through Survey Monkey or via a phone call if no email was available. The feedback

survey questions were adapted from other feasibility studies and face validity was obtained (See

Appendix J). The survey contained 10 questions pertaining to the walking plan with Likert scale

possible answers. A participants' email and phone number were a part of the consent and

entered onto the confidential identity key at the start of the project. Participants consented to

receiving a feedback survey. Participants that did not complete the walking plan still received a

feedback survey. Two attempts were made for collection of the feedback survey. After the initial

feedback survey was emailed or a phone call was placed, a follow-up email or phone call

occurred if no response within one week.

Data collection included participant self-reported PA time and exertion level for the four-

week walking plan. To determine the intensity of the walks, a perceived exertion scale was used.

Because of heart rate responses to PA in pregnant women, the use of ratings of perceived

exertion is a more effective means to monitor exercise intensity during pregnancy than heart rate

parameters (ACOG, 2015). The perceived exertion scale used in this project is approved by the CDC (CDC, 2015). Gestational age at the start of the walking plan was collected by the co-investigator from the EHR. No compensation was given to participants, and no additional costs were needed for participation in the project.

Outcomes

Eight participants were enrolled into the feasibility project. Two participants dropped out after week two, but their data was still included in weeks one and two. Six participants completed all four weeks of the walking plan. There were some participants that did not walk every week. The average gestational age at the start of the walking plan was 28 weeks with a range from 17 to 34 weeks gestation.

Week one of the walking plan, six out of eight participants (80%), completed some portion of the walking plan; meaning two participants did not complete any walking. On week two, five out of eight participants (63%) completed some portion of the walking plan. Missing data is noted from one participant in week two and therefore the missing data is counted as no walking. Week three, three out six participants (50%) completed some portion of the walking plan. Week four, two out of six participants (33%) completed some portion of the walking plan. For individual participant walking minutes per week, see Appendix H. As the walking plan progressed, a decrease in compliance with the scheduled amount of walking time was noted.

A non-parametric Friedman test of differences among repeated measures was conducted and rendered a Chi-square value of 11.12 which was significant ($p < .025$) for walking among all participants in all weeks of the walking plan versus their baseline data. This is statistically significant with the participants increase in PA from baseline data throughout all weeks of the walking plan. For individual week data, see Appendix I.

Four out of the eight (50%) participants completed the post-intervention survey. Of those that completed the survey, 100% agreed that the walking plan was useful and increased their awareness about PA and walking during pregnancy. Seventy-five percent agreed the walking plan was trustworthy, made them feel good, was easy to read, looked professional, was not judgmental, and did not give too much information. Twenty-five percent agreed that the walking plan contained new information, and 50% agreed that the walking plan encouraged them to try something new. These results suggest that the walking plan made the participants think about their PA in pregnancy and the outcomes it can have on their health. The survey also revealed that participants felt the actual walking plan was easy to follow and this could easily be implemented in other clinical sites and in different populations where PA is encouraged.

Discussion

Although first line therapy for the treatment of GDM is lifestyle modifications including dietary changes and PA incorporation, exercise is routinely unused. This project shows a simple, brief intervention consisting of a four-week structured walking plan, that successfully increased PA among participants. The increase in walking among participants shows an improvement in PA over baseline. The decrease in the compliance with the walking plan shows that follow-up is needed, especially in the third and fourth week where compliance was noted to be only at 50% and 33% respectively. A decrease in compliance could be related to time, a quick increase in walking time over a short period, or pregnancy and health related issues. In-person follow-up could be an added component that may be more effective for a sustained behavior change.

The impact of the project is significant on many levels. For the participant, the increase in PA shows an increase in awareness and knowledge regarding PA. This leads to better health outcomes during pregnancy, as well as motivation for continuing PA after pregnancy to maintain

a healthy lifestyle. For healthcare providers, the walking plan increases adherence to national guidelines for PA in pregnancy and its inclusion provides a more comprehensive compendium of GDM care. For the project site's system, the walking plan is a sustainable system change and is feasible to implement in other clinical locations. While the structured walking plan has not been implemented into the other practice sites, all other practice sites are tracking PA along with SBG levels. The project impacts policy by having the potential to decrease diabetes costs and aligns with global health policy.

The increased PA among participants that agreed to follow a structured walking plan replicates finding from earlier research. Similar findings include women who were previously sedentary were able to successfully follow a moderate intensity-walking program (Davenport et al., 2008). In another study, an unsupervised walking program increased moderate intensity activity in overweight and obese pregnant women (Kong et al., 2014). This project's outcomes contribute to the current literature knowledge.

Recommendations for future research include the effect on the use of oral medication and insulin in GDM pregnancies that participate in a structured walking plan. Future research could also focus on the long-term benefits of a structured walking plan among GDM pregnancies. A follow-up project could be conducted to look at the compliance with the walking plan when more follow-up is done after the initial teaching.

 The strength of this project lies in the PA changes participants achieved. The participants' willingness to participate in the walking plan as well as awareness about PA incorporated into GDM care are also major strengths of this project. Walking is a practical PA remedy because it uses minimum equipment, is free and easily accessible for all women therefore making it highly accessible. Two participants achieved the national PA

recommendations of walking over 150 minutes over a week. This shows that meeting these recommendations can be achieved.

There were limitations in this project. Despite efforts to recruit a larger number of participants, actual recruitment was low, therefore the statistical power to detect significant difference is limited. There was a lower amount of PA uptake noted in the third and fourth week of the walking plan. There was also a 25% (n=2) dropout rate. The dropouts could be related to transferring care from the project practice site, delivery, or unwillingness to participant in the project. There were also some weeks where participants either did not walk or did not log their walking. This could have the potential to skew the outcomes. Only half of the participants (n=4) completed the feasibility survey at the end of the walking plan. Dietary intake was not tracked or analyzed; however dietary education was not changed. SBG levels as well as A1C levels were not collected or studied. The project only used one modality of PA, walking; yoga or other forms of PA that were performed were not included in this project.

Conclusion

The walking plan is worth assessing for further use in the plan of care of GDM patients. The addition of a structured walking plan in GDM teaching is an effective strategy to lower SBG levels and for meeting PA recommendations during pregnancy. The project shows it is feasible to incorporate PA into comprehensive GDM care and positive movement is made towards incorporating first line therapy. Results show that follow-up communication with participants is needed after the initial walking plan teaching as higher rates of participation were noted in week one and week two.

Future work on the project would include all practice locations implementing the walking plan into comprehensive GDM care as well as using the walking plan as a tool to have open

ended conversation with patients about their PA. Furthermore, using the PA section on the SBG

log to discuss PA expectations will help meet national guidelines for PA in pregnancy and can

create motivation to make a positive health modification. The PA completed by participates in

this project had many benefits and if continued will have a lifelong impact.

References

Ajzen, I. (1985). From intentions to actions: A theory of planned behavior. *In Action Control*

(pp. 11-39). Springer, Berlin, Heidelberg.

American College of Obstetricians and Gynecologist (ACOG). (2018). Practice bulletin No. 190:

Gestational diabetes mellitus. *Obstetrics & Gynecology, 131*(2), e49-e64.

doi:10.1097/aog.0000000000002501

American College of Obstetricians and Gynecologist (ACOG). (2017). Practice bulletin no.180:

Gestational diabetes mellitus. *Obstetrics & Gynecology, 130,* 17-31. doi:

10.1097/AOG.0000000000002159

American College of Obstetricians and Gynecologist (ACOG). (2015). Committee opinion no.

650: Physical activity and exercise during pregnancy and the postpartum period.

Obstetrics & Gynecology, 126, e135-e142. doi: 10.1097/AOG.0000000000001214

American Diabetes Association (ADA). (2018). Diabetes costs. *American Diabetes Association.*

Retrieved from: http://www.diabetes.org

American Diabetes Association (ADA). (2016). What is gestational diabetes. *American Diabetes*

Association. Retrieved from: http://www.diabetes.org

Anjana, R. M., Sudha, V., Lakshmipriya, N., Anitha, C., Unnikrishnan, R., Bhavadharini, B., . . .

Mohan, V. (2016). Physical activity patterns and gestational diabetes outcomes: The

wings project. *Diabetes Research and Clinical Practice, 116*, 253-262.

doi:10.1016/j.diabres.2016.04.041

Arizona Department of Health Services Bureau of Tobacco and Chronic Disease. (2018).

Diabetes in Arizona: the 2018 burden report. Retrieved from:

https://www.azdhs.gov/documents/prevention/tobacco-chronic-disease/diabetes/reports-data/diabetes-burden-report-2018.pdf

Barros, M. C., Lopes, M. A., Francisco, R. P., Sapienza, A. D., & Zugaib, M. (2010). Resistance exercise and glycemic control in women with gestational diabetes mellitus. *American Journal of Obstetrics and Gynecology, 203*(6). doi:10.1016/j.ajog.2010.07.015

Bgeginski, R., Ribeiro, P. A., Mottola, M. F., & Ramos, J. G. (2017). Effects of weekly supervised exercise or physical activity counseling on fasting blood glucose in women diagnosed with gestational diabetes mellitus: A systematic review and meta-analysis of randomized trials. *Journal of Diabetes, 9*(11), 1023-1032. doi:10.1111/1753-0407.12519

Canadian Society for Exercise Physiology (2015). *PARmed-X for pregnancy: Physical activity readiness medical examination.* Retrieved from http://www.csep.ca/CMFiles/publications/parq/parmed-xpreg.pdf

Centers for Disease Control and Prevention (CDC). (2018). *Gestational diabetes and pregnancy.* Retrieved from https://www.cdc.gov/pregnancy/diabetes-gestational

Centers from Disease Control and Prevention (CDC). (2015). *Physical activity.* Retrieved from http://www.cdc.gov/physicalactivity

Davenport, M. H., Mottola, M. F., McManus, R., & Gratton, R. (2008). A walking intervention improves capillary glucose control in women with gestational diabetes mellitus: A pilot study. *Applied Physiology, Nutrition, and Metabolism, 33,* 511-517. doi: 10.1139/h08-018

DiPietro, L., Gribok, A., Stevens, M. S., Hamm, L. F., & Rumpler, W. (2013). Three 15-min bouts of moderate postmeal walking significantly improves 24-h glycemic control in

older people at risk for impaired glucose tolerance. *Diabetes Care, 36*(10), 3262-3268. doi:10.2337/dc13-0084

Downs, D. S., DiNallo, J. M., Birch, L. L., Paul, I. M., & Ulbrecht, J. S. (2017). Randomized face-to-face vs. home exercise interventions in pregnant women with gestational diabetes. *Psychology of Sport and Exercise*, *30*, 73-81. doi:10.1016/j.psychsport.2017.02.003

Ehrlich, S. F., Hedderson, M. M., Brown, S. D., Sternfeld, B., Chasan-Taber, L., Feng, J., ... & Ferrara, A. (2017). Moderate intensity sports and exercise is associated with glycaemic control in women with gestational diabetes. *Diabetes & Metabolism, 43*(5), 416-423. doi:10.1016/j.diabet.2017.01.006

Ferrara, A. (2007). Increasing prevalence of gestational diabetes mellitus: A public health perspective. *Diabetes Care, 30*, S141-S146. doi:10.2337/dc07-s206

Han, S., Middleton, P. F., Tran, T. S., & Crowther, C. A. (2016). Assessing use of a printed lifestyle intervention tool by women with borderline gestational diabetes and their achievement of diet and exercise goals: a descriptive study. *BMC Pregnancy and Childbirth, 16*(1). doi:10.1186/s12884-016-0825-z

Harrison, A. L., Shields, N., Taylor, N. F., & Frawley, H. C. (2016). Exercise improves glycemic control in women diagnosed with gestational diabetes mellitus: A systematic review. *Journal of Physiotherapy, 62*(4), 188-196. doi:10.1016/j.jphys.2016.08.003

Kaaja, R., & Ronnemaa, T. (2008). Gestational diabetes: Pathogenesis and consequences to mother and offspring. *The Review of Diabetes Studies: RDS, 5*(4), 194-202. doi: 10.1900/RDS.2008.5.194.

Kim, Y., & Chung, E. (2015). Descriptive epidemiology of objectively measured walking among

US pregnancy women: National health and nutrition examination survey, 2005-2006.

Preventing Chronic Disease, 12, e2-e17. doi: 10.5888/pcd12.150437

Kokic, I. S., Ivanisevic, M., Biolo, G., Simunic, B., Kokic, T., & Pisot, R. (2018). Combination

of a structured aerobic and resistance exercise improves glycaemic control in pregnant

women diagnosed with gestational diabetes mellitus. A randomised controlled trial.

Women and Birth, 31(4). doi:10.1016/j.wombi.2017.10.004

Kong, K. L., Campbell, C. G., Foster, R. C., Peterson, A. D., & Lanningham-Foster, L. (2014). A

pilot walking program promotes moderate-intensity physical activity during pregnancy.

Medicine and Science in Sports and Exercise, 46(3), 462-471. doi:

10.1249/MSS.0000000000000141

Noctor, E., & Dunne, F. P. (2015). Type 2 diabetes after gestational diabetes: the influence of

changing diagnostic criteria. *World Journal of Diabetes, 6*(2), 234. doi:

10.4239/wjd.v6.i2.234

Padmapriya, N., Bernard, J. Y., Liang, S., Loy, S. L., Cai, S., Zhe, I. S., ... & Chong, Y. S.

(2017). Associations of physical activity and sedentary behavior during pregnancy with

gestational diabetes mellitus among Asian women in Singapore. *BMC Pregnancy and

Childbirth, 17*(1), 364. doi:10.1186/s12884-017-1537-8

Titler, M.G., Kleiber, C., Steelman, V.J., Rakel, B.A., Budreau, G., Everett, L.Q., . . . Goode,

C.J. (2001). The Iowa model of evidence based practice to promote quality care. *Critical

Care Nursing Clinics of North America, 13,* 497–509. doi: 10.1016/S0899-

5885(18)30017-0

U.S. Department of Health and Human Services. (2018). *Physical activity guidelines for*

  Americans (2nd edition). Retrieved from https://health.gov/paguidelines/second-

  edition/pdf/Physical_Activity_Guidelines_2nd_edition.pdf
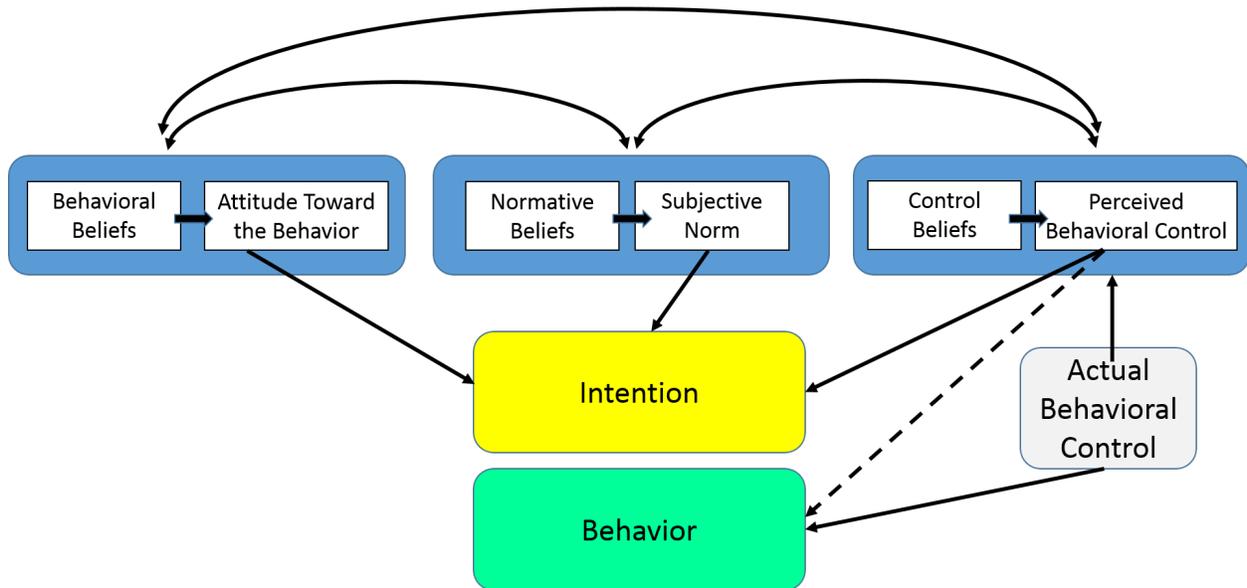
Youngwanichsetha, S., Phumdoung, S., & Ingkathawornwong, T. (2014). The effects of

  mindfulness eating and yoga exercise on blood sugar levels of pregnant women with

  gestational diabetes mellitus. *Applied Nursing Research, 27*(4), 227-230.

  doi:10.1016/j.apnr.2014.02.002

Appendix A
Synthesis Table

	Studies	Aniana, R. M. et al.	Youngwanichesta, S. et al.	Padmapriya, N. et al.	Downs, D. et al.	Ehrlich, S.F. et al.	Han, S. et al.	Barros, M.C. et al.	Harrison, A.L. et al.	Bgeginski, R. et al.	Kokic, I. et al.
Basics	Year	2016	2014	2017	2017	2017	2016	2010	2016	2016	2017
	LOE	I	II	I	II	II	II	I	II	II	II
	Design	SR	RCT	SR	RCT	RCT	RCT	SR	RCT	RCT	RCT
	GDM pts	X	X	X	X	X	X	X	X	X	X
	Mean Age	N/A	N/A	18 yrs	32 yrs	31.9 yrs	31.3 yrs	32.4 yrs	32 yrs	N/A	31.95 yrs
	Attrition	80%	94%	N/A	N/A	89%	100%	100%	90, 96, 100, 80%	90, 96, 80, 70%%	90%
	Bias	None	None	LR	None	None	None	None	None	None	None
	# of participants	189	189	1085	65	971	56	64	588	8	38
Interventions	Physical Activity	X	X	X	X	X	X	X	X	X	X
	Mindful Eating		X				X				
	Nutritional Counselling		X	X			X		X	X	
	Sedentary Behavior	X		X							X
	One on One PA Counsel				X	X			X	X	
	Pedometer Use	X			X						
	Goal Setting	X					X				
Major findings	Fasting Capillary Glucose	X	X	X	X	X		X	X	X	X
	Postprandial BG		X	X	X	X		X	X		X
	A1C	X	X						X	X	
	Medication Use				X			X	X	X	
	Exercise Goals				X		X				
	BMI	X	X			X		X	X		X
	Neonatal Outcomes	X						X	X	X	X
	Step Count	X					X				

Appendix B
Theory of Planned Behavior


```
  Behavioral   Attitude Toward      Normative   Subjective      Control     Perceived
  Beliefs  →   the Behavior         Beliefs  →  Norm            Beliefs  →  Behavioral Control
```

Intention

Behavior

Actual
Behavioral
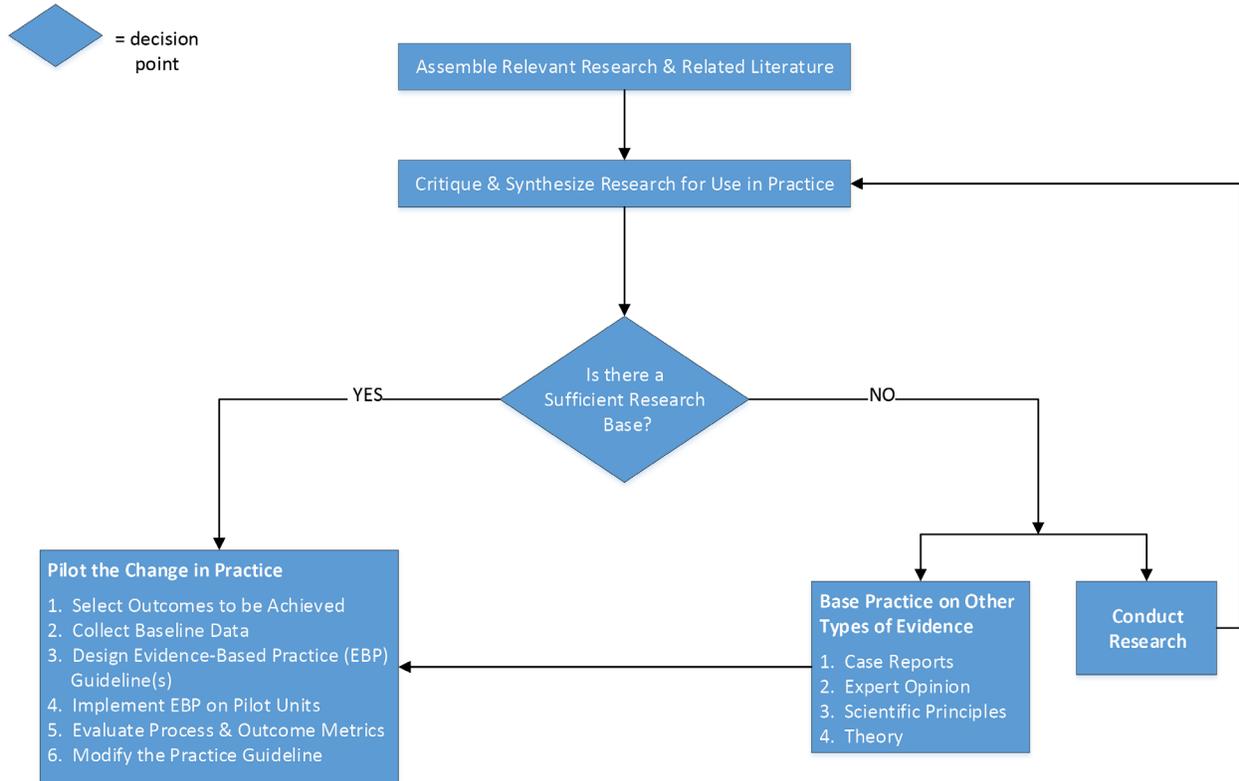Control

Note. Theory of Planned Behavior adapted from Ajzen, I. (1985). From intentions to actions: A theory of planned behavior. *In Action Control* (pp. 11-39). Springer, Berlin, Heidelberg.

Appendix C
The Iowa Model of Evidence Based Practice to Promote Quality Care

The Iowa Model of Evidence Based Practice to Promote Quality Care

◆ = decision point

Assemble Relevant Research & Related Literature

↓

Critique & Synthesize Research for Use in Practice

↓

Is there a Sufficient Research Base?

YES ← → NO

Pilot the Change in Practice

1. Select Outcomes to be Achieved
2. Collect Baseline Data
3. Design Evidence-Based Practice (EBP) Guideline(s)
4. Implement EBP on Pilot Units
5. Evaluate Process & Outcome Metrics
6. Modify the Practice Guideline

Base Practice on Other Types of Evidence

1. Case Reports
2. Expert Opinion
3. Scientific Principles
4. Theory

Conduct Research

Note. Adapted from Titler, M.G., Kleiber, C., Steelman, V.J., Rakel, B.A., Budreau, G., Everett, L.Q., . . . Goode, C.J. (2001). The Iowa Model of evidence based practice to promote quality care. *Critical Care Nursing Clinics of North America, 13,* 497–509. doi: 10.1016/S0899-5885(18)30017-0

Appendix D
Physical Activity and Exercise During Pregnancy and the Postpartum Period

Relative Contraindications	Absolute Contraindications
Anemia	hemodynamically significant heart disease
unevaluated maternal cardiac arrhythmia	restrictive lung disease
chronic bronchitis	incompetent cervix or cerclage
poorly controlled type 1 diabetes	multiple gestation at risk for premature labor
extreme morbid obesity	persistent second or third trimester bleeding
extreme underweight (BMI below 12)	ruptured membranes
history of extremely sedentary lifestyle	preeclampsia or pregnancy induced hypertension
intrauterine growth restriction in current pregnancy	severe anemia
poorly controlled hypertension	
orthopedic limitations	
poorly controlled seizure disorder	
poorly controlled hyperthyroidism	
heavy smoker	

Notes. Adapted from American College of Obstetricians and Gynecologist (ACOG). (2015). Committee opinion no. 650: Physical activity and exercise during pregnancy and the postpartum period. *Obstetrics & Gynecology, 126,* e135-e142. doi: 10.1097/AOG.0000000000001214

Appendix E

Walking Plan for Previously Inactive Women in Pregnancy

	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Week 1	Rest	WU: 3 min. easy walk, 10 min. brisk walk CD: 3 min. easy walk	Rest	WU: 3 min. easy walk 10 min. brisk walk CD: 3 min. easy walk	Rest	Rest	WU: 3 min. easy walk 10 min. brisk walk CD: 3 min. easy walk
Week 2	Rest	WU: 3 min. easy walk 12 min. brisk walk CD: 3 min. easy walk	Rest	WU: 3 min. easy walk 15 min. brisk walk CD: 3 min. easy walk	WU: 3 min. easy walk 15 min. brisk walk CD: 3 min. easy walk	Rest	WU: 3 min. easy walk 15 min. brisk walk CD: 3 min. easy walk
Week 3	Rest	WU: 3 min. easy walk 20 min. brisk walk CD: 3 min. easy walk	Rest	WU: 3 min. easy walk 20 min. brisk walk CD: 3 min. easy walk	WU: 3 min. easy walk 20 min. brisk walk CD: 3 min. easy walk	Rest	WU: 3 min. easy walk 20 min. brisk walk CD: 3 min. easy walk
Week 4	WU: 3 min. easy walk 25 min. brisk walk CD: 3 min. easy walk	WU: 3 min. easy walk 25 min. brisk walk CD: 3 min. easy walk	Rest	WU: 3 min. easy walk 25 min. brisk walk CD: 3 min. easy walk	WU: 3 min. easy walk 25 min. brisk walk CD: 3 min. easy walk	Rest	WU: 3 min. easy walk 25 min. brisk walk CD: 3 min. easy walk

WU: warm-up; **CD:** cool-down; **Min:** minutes

Reasons to Stop Exercise and Consult your Health Care Provider

• Vaginal bleeding
• Regular painful contractions
• Amniotic fluid leakage
• Shortness of breath before exertion
• Dizziness
• Headache
• Chest pain
• Muscle weakness affecting balance
• Calf pain or swelling

Safety Considerations

• Drink liquids and eat before and after exercise

• Avoid exercise in warm/humid environments

• Know the reasons to stop exercise and check with your health care provider

How hard am I exercising?

• Score your exercise effort using **Light, Moderate, and Vigorous** activities. Light activity for example is an "easy" walk including the warm up and cool down. A moderate activity is a "brisk" walk. Vigorous activity is race walking or jogging (CDC, 2015).

• Use the "talk test" to measure your exertion level. You should always be able to carry on a conversation while exercising.

The American College of Obstetricians and Gynecologist (ACOG). (2015) Committee Opinion No. 650 Physical activity and exercise during pregnancy and the postpartum period. *Obstetrics & Gynecology, 126*(6), 1326–1327. doi: 10.1097/aog.0000000000001209. Centers for Disease Control and Prevention (CDC). (2015). Measuring Physical Activity Intensity. Retrieved from https://www.cdc.gov/physicalactivity/basics/measuring/index.html

Appendix F
PA Tracking Log

Day of week: Date:	Breakfast	Snack	Lunch	Snack	Dinner	Snack
	Time:	Time:	Time:	Time:	Time:	Time:
	Carb #	Carb #	Carb #	Carb #	Carb #	Carb #
	Physical activity (Circle one):		Effort level: **Light Moderate Vigorous** (circle one)			Total hrs/mins:

Day of week: Date:	Breakfast	Snack	Lunch	Snack	Dinner	Snack
	Time:	Time:	Time:	Time:	Time:	Time:
	Carb #	Carb #	Carb #	Carb #	Carb #	Carb #
	Physical activity (Circle one):		Effort level: **Light Moderate Vigorous** (circle one)			Total hrs/mins:

Day of week: Date:	Breakfast	Snack	Lunch	Snack	Dinner	Snack
	Time:	Time:	Time:	Time:	Time:	Time:
	Carb #	Carb #	Carb #	Carb #	Carb #	Carb #
	Physical activity (Circle one):		Effort level: **Light Moderate Vigorous** (circle one)			Total hrs/mins:

Appendix J
Feedback Survey Questions

1.   Was the walking plan easy to read (made sense)?

Strongly agree (5), agree (4), neutral (3), disagree (2), strongly disagree (1)

2.   Did the walking plan look professional?

Strongly agree (5), agree (4), neutral (3), disagree (2), strongly disagree (1)

3.   Did the walking plan give you information you can trust?

Strongly agree (5), agree (4), neutral (3), disagree (2), strongly disagree (1)

4.   Did you find the walking plan useful?

Strongly agree (5), agree (4), neutral (3), disagree (2), strongly disagree (1)

5.   Did the walking plan make you think about your physical activity?

Strongly agree (5), agree (4), neutral (3), disagree (2), strongly disagree (1)

6.   Did the walking plan contain new information?

Strongly agree (5), agree (4), neutral (3), disagree (2), strongly disagree (1)

7.   Did the walking plan encourage you to try something new?

Strongly agree (5), agree (4), neutral (3), disagree (2), strongly disagree (1)

8.   Did the walking plan make you feel good?

Strongly agree (5), agree (4), neutral (3), disagree (2), strongly disagree (1)
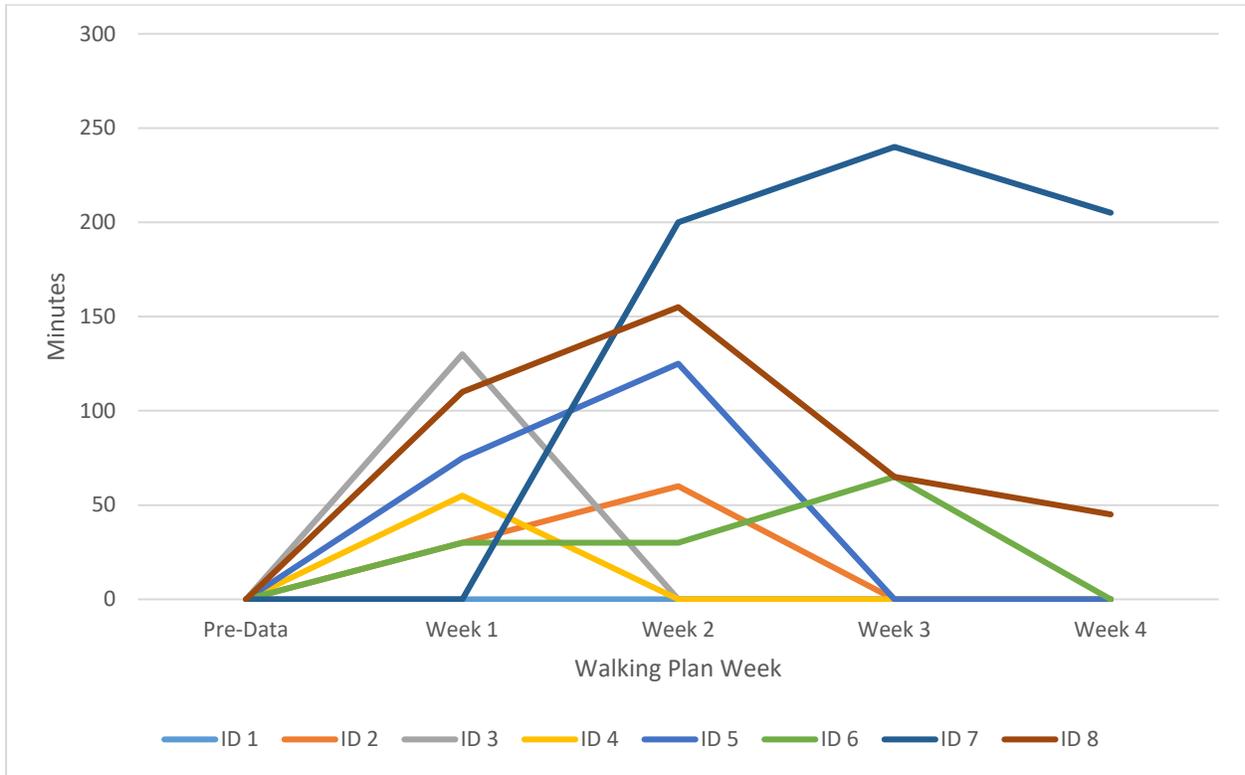
9.   Did you find the walking plan judgmental?

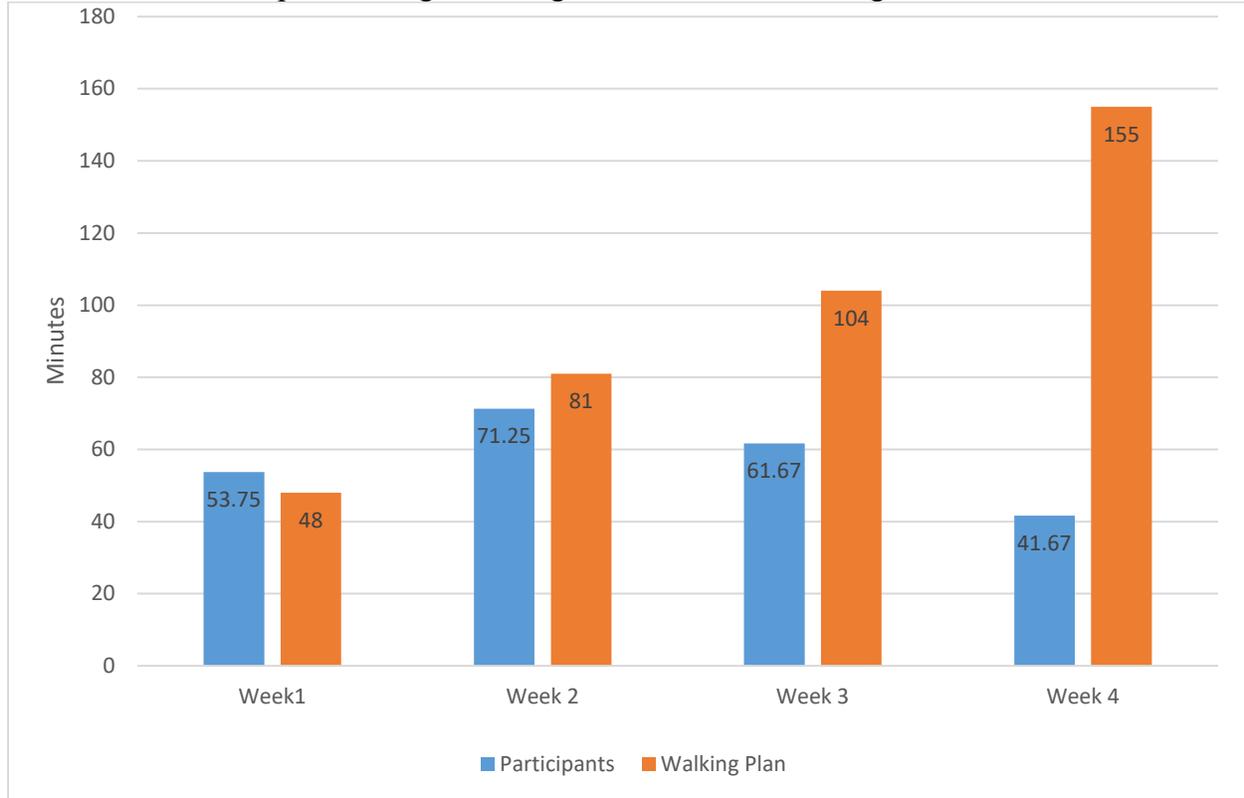Strongly agree (5), agree (4), neutral (3), disagree (2), strongly disagree (1)

10.   Did the walking plan give you too much information?

Strongly agree (5), agree (4), neutral (3), disagree (2), strongly disagree (1)

Appendix H
Walking Time by Participant

Appendix I
Participant Average Walking Minutes versus Walking Plan Minutes

Note. A Wilcoxon Signed-Ranks test indicated that the median post-test ranks were statistically significantly higher than the median pre-test ranks in week one ($Z = -2.027^b$, $p < .027$) and week two ($Z = -2.023^b$, $p < .043$). When compared to the pre-data, week three ($Z = -1.633^b$, $p < .102$) and week four ($Z = -1.342^b$, $p < .180$) were not statistically significant in an increase in PA.