Low-Touch Physical Activity Intervention through Facebook in Pregnant Women

by

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B.S. Exercise Science, Slippery Rock University, 2019

Submitted to the Graduate Faculty of the

School of Education in partial fulfillment

of the requirements for the degree of

Master of Science

University of Pittsburgh

2022

UNIVERSITY OF PITTSBURGH

SCHOOL OF EDUCATION

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May 6, 2022

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In the past, pregnancy was thought of as a medical condition requiring rest. Today, research has shown many health benefits of physical activity during pregnancy. This study aimed to increase physical activity in pregnant women with a translatable, low-touch social media intervention designed to address barriers to physical activity and facilitate social support from other pregnant women. Specifically, we studied whether our intervention increased social support and outcome expectations and decreased barriers to physical activity. We also examined preliminary effects, acceptance, and enjoyment of our intervention on physical activity over 8 weeks.

Ten women recruited through prenatal clinics and Facebook ads completed baseline and follow-up assessments. The women in this study were White, averaged 32±6 years old, and had a gestational age of 17.3±2.2 weeks. Along with joining a private Facebook group, objective weekly steps and active minutes were collected through a study-provided Fitbit Luxe worn by the women during waking hours. Baseline and follow-up assessments included the Pregnancy Physical Activity Questionnaire, Exercise Outcomes and Expectations Questionnaire, and the Social Support for Exercise Questionnaire. Additionally at follow-up, participants completed a program evaluation questionnaire. Paired t-tests analyzed data from pre-post questionnaires and mixed linear models evaluated changes in objective steps and activity across the study.

All participants completed the follow-up assessment. There were no significant differences comparing baseline measures to 8-week data (all $p>0.05$). However, potentially clinically

meaningful increases were observed for social support for physical activity (from 21.1±7.2 to 25.2±9.9 points) and self-reported moderate-to-vigorous intensity activity (from 113.7±97.2 to 162.8±107.4 minutes per week, p=0.3998) . Objectively-measured steps and active minutes did not change over the 8-week follow-up (p=0.954, p=0.672 respectively). The program evaluation showed high enjoyment and acceptability for the Fitbit and Facebook. Participants reported that education-based posts influenced physical activity the most, but interactive posts were most enjoyable. In the future, similar studies may want to include a control group, collect data over the entire pregnancy, and consider a health coaching approach. In conclusion, this study demonstrated initial feasibility, some possibly meaningful effects, and promising information for future interventions focused on increasing physical activity in pregnant women.

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1.0 Introduction

Federal Guidelines from the Department of Health and Human Services, the American College of Sports Medicine (ACSM), and the American College of Obstetrics and Gynecology (ACOG) all recommend that pregnant women should get 20-30 minutes of physical activity a day, or about 150 minutes of physical activity per week. Yet, few women meet these recommendations. National estimates in pregnant women show that the prevalence of meeting physical activity recommendations ranges from 16% to 25% [1, 2]. There are many benefits to physical activity during pregnancy including decreased pain during labor, decreased risk of gestational diabetes, improving muscular strength, and an increase in general health. Considering the many benefits of physical activity and low participation rates, strategies to increase physical activity in pregnant women are needed.

Many studies have assessed the barriers to and facilitators of physical activity in pregnant women. These include lack of time, discomfort, low social support, lack of accessible and affordable physical activity programs, lack of childcare, concern for their baby's health, fatigue, and low motivation or enjoyment [3-7]. Studies have also examined physical activity interventions in pregnant women to address these barriers, but very few have assessed low-touch methods that could address time constraints, have a low participant burden, and have high potential for translation. With the rise of social media usage, especially among women of childbearing age,[8], delivering a physical activity intervention to pregnant women via social media (such as Facebook) may be feasible and effective. Yet, there are few studies examining a low touch intervention delivered exclusively through social media for increasing physical activity in pregnant women. By using a private Facebook group as the intervention platform, we hypothesized that we could easily

reach pregnant women in a comfortable setting that would help women address their barriers to physical activity and encourage social support among participants. However, whether this type of intervention would be acceptable and enjoyable, could reduce barriers to physical activity, and could increase physical activity levels in pregnant women remains unknown. Therefore, this study will address the following aims:

Aim 1. Evaluate the effect of a low-touch, social media physical activity intervention in pregnant women on social support, barriers, and outcome expectations over eight weeks

Hypothesis. The intervention will increase social support, decrease barriers, and improve outcome expectations with respect to physical activity.

Aim 2. Evaluate the effect of a low-touch, social media physical activity intervention in pregnant women on physical activity over eight weeks

Hypothesis. The intervention will increase objective steps per day and active minutes as well as self-reported moderate-to-vigorous physical activity.

Aim 3. Assess the acceptability and enjoyment of a low-touch, social media physical activity intervention in pregnant women

Hypothesis: Pregnant women will find the intervention acceptable and enjoyable.

Results from this study will provide preliminary data to support a low-touch, social media strategy for encouraging physical activity in pregnant women. If successful, the ease of delivery

of this type of physical activity intervention could be used on a larger scale among pregnant populations.

2.0 Review of the Literature

2.1 History of Physical Activity Recommendations in Pregnancy

Exercise and physical activity have been widely accepted as a healthy lifestyle recommendation for centuries. There are guidelines in the United States for all age groups and most special populations. However, one population that has had variable recommendations over time is pregnant women. As social standards of women have changed through history, the societal expectations of women's health and activity habits have changed as well. It was not until the 1900s that a shift in ideal body image changed from a heavier, curvy physique to a thin physique [9]. Understanding the societal expectations of women then and now may help to explain how pregnant women's attitudes and barriers toward physical activity and exercise recommendations are today.

Exercise and physical activity recommendations for women date back to the early 18th century. At this time, women primarily participated in physical activity to maintain a physique normalized by society. Although some healthcare professionals endorsed increasing physical activity during pregnancy, it was not until the late 19th and early 20th century that research was conducted to study whether physical activity could improve labor and delivery outcomes and reduce the size of the baby [10]. Exercise became more popular and accepted at this time and the first prenatal exercise program was introduced with hopes of decreasing labor pains and provide an easier labor and delivery, improving oxygen to the fetus, and assisting in postpartum weight loss[11]. Yet, while scientific studies concluded that higher physical activity was related to a healthier birthweights and lower physical activity was associated with excessive birthweights, there was still skepticism from women in regards to possible harm to the fetus [10].

In 1949, the US Children's Bureau set a standard recommendation for physical activity in prenatal women stating that some exercise was good for pregnancy health (swimming, walking in short bouts, housework) but that sports should be avoided [12]. Commercial exercise programming in the 1970's and 1980's was directly related to these recommendations. In 1985, ACOG released official guidelines for physical activity and exercise for the pregnant population suggesting limiting heart rate and duration during exercise. However, these restrictions were removed in 1994 after no scientific evidence identified harmful effects. In 2002, ACOG released a statement outlining the benefits and safety of exercise for all women and promoting 30 minutes of exercise most days of the week. In 2008 the United States Department of Health and Human Services (USDHHS) released "Physical Activity Guidelines for Americans" which were consistent with the ACOG recommendations. In 2015, ACOG refined their recommendation from 30 minutes to 20-30 of exercise most days of the week [2]. Table 1 (next page) outlines the timeline of historical exercise and physical activity recommendations for pregnant women from 1949 through 2015.

Table 1. Pregnancy Physical Activity Recommendations throughout History

Year	Association	Guideline Details
1949	United States Children's Bureau	These recommendations stated that as long as there were no maternal complications, women could continue housework, gardening, and daily walks up to 1-mile in several short bouts, and swim occasionally, but should avoid sports participation.
1985	American College of Obstetricians and Gynecologists	The first formal Guidelines for prenatal physical activity were published. Most aerobic activity was recommended, but caution was advised with high impact activities. Restrictions included that heart rate should be no more than 140 beats per minute, exercise should last no more than 15 minutes at a time, and core body temperature should be no higher than 100.4°F. Women that were not exercising prior to pregnancy were advised not to start.
1994	American College of Obstetricians and Gynecologists	Heart rate and duration limitations were removed. Instead the Guidelines stated that "exercise can be done in moderation but not exhaustion."
2002	American College of Obstetricians and Gynecologists	Statement was released promoting benefits and safety of 30 minutes of exercise on most days of the week for all pregnant women with a medical clearance and if no contraindications were present.
2008	United States Department of Health and Human Services	All pregnant women (previously active and inactive) were encouraged to engage in at least 150 minutes per week of moderate-intensity PA. Women previously not active should obtain 150 minutes in 10-minute bouts along with a medical clearance and if no contraindications were present. Pregnant women who habitually engaged in vigorous-intensity aerobic activity should continue under supervision of a health care provider.
2009	American College of Obstetricians and Gynecologists	Engagement in 30 minutes or more of exercise of moderate intensity on most days of the week for pregnant women was reaffirmed.
2015	American College of Obstetricians and Gynecologists	Engagement in 20-30 minutes or more of exercise of moderate intensity on most days of the week was reaffirmed.
2018	United States Department of Health and Human Services	The Guidelines from the United Sates Department of Health and Human Services in 2008 was reaffirmed

2.2 Current Physical Activity & Exercise Guidelines during Pregnancy

ACOG, ACSM, and the U.S. Department of Health and Human Services each provide standard, current guidelines for pregnant and postpartum women with similar recommendations (comparison across Guidelines in Table 2). ACOG established recommendations and guidelines for pregnant women by expert opinion from a panel of obstetricians and gynecologists. Meredith L. Birsner MD, a lead author of the committee opinion said in the update released on March 26, 2020 "Generally we want to encourage women who already engage in exercise to continue to engage in some form of physical activity that is appropriate for them as an essential component of a healthy lifestyle and pregnancy" [13]. ACOG endorses the safety of physical activity before, during, and after pregnancy. Similarly, ACSM states "All women without contraindication should be physically active throughout their pregnancy, including previously inactive, those with gestational diabetes, and those overweight and obese," in regards to physical activity levels [14]. After scientific studies, ACSM concluded that the benefits of physical activity outweigh the possible risks. These benefits are described in detail in the following section of this chapter (see section 2.3). The 2018 Physical Activity Guidelines for Americans, including pregnant women, provide detailed recommendations in regards to the specific previous experience level of pregnant women.

Table 2. Current Physical Activity Guideline Comparison

Guideline Categories	Guidelines		
	American College of Obstetricians and Gynecologists (2015)	**American College of Sports Medicine (2009)**	**U.S. Guidelines for Physical Activity in Americans (2018)**
General Guidelines for Healthy Woman with Uncomplicated Pregnancy	20-30 minutes/day of exercise on most days/week	150 minutes of moderate intensity physical activity each week Encouraged every day, with a minimum of 3 days per week Incorporate aerobic, resistance, and flexibility training along with yoga in weekly activity	At least 150 minutes of moderate intensity aerobic activity through the week
Previously Regularly Active Women (Moderate Intensity)			Light to moderate intensity aerobic and muscle strengthening activity
Not Previously Active Women (Beginners/Light Intensity)			Light to moderate aerobic and muscle strengthening activity, with gradual increases over time
Pregnant Athletes (Vigorous Intensity)	Vigorous activity into the third trimester seems to be safe. May resume higher intensity training after pregnancy		Continue physical activity during and after childbirth. Do not drastically reduce activity levels
Pregnant Women with Pre-Pregnancy Obesity	Start with low intensity and short periods of time, gradually increase time and intensity as tolerable Obstetric or medical comorbidities should have an individualized program		
Other Recommendations	Some exercise may need modification due to anatomical changes during pregnancy Pregnant women should be evaluated by medical professional before prescribing an exercise program During exercise, women should stay well hydrated, wear loose fitted clothing, and avoid high heat and humidity.	Pelvic floor exercises recommended daily Warm-up and cool-down periods suggested Avoid high heat or humidity, activities with an increased falling risk, and contact sports or activities with increased risk of blunt force trauma Maintain adequate nutrition and hydration before, during, and after physical activity	Do not engage in activities involving lying on your back after the first trimester Avoid contact sports and activities

2.3 Benefits of Physical Activity during Pregnancy

Historically, pregnancy was seen as a 9-month illness or a time during which women should take extreme care of their body [15]. As such, bed rest and strict restrictions on physical activity were the accepted "treatment" for pregnancy. Since then, clinical understanding of pregnancy has changed. Physical activity is no longer contraindicated for pregnant women, but is now seen as a healthy, recommended behavior (see previous section, 2.2) that can reduce the risk of mental and physical complications during pregnancy. Those who participate in an active lifestyle pre-pregnancy are recommended to continue these behaviors, and there is minimal risk along with considerable benefits to initiating physical activity during pregnancy [13].

Some of the most prominent benefits to physical activity and exercise during pregnancy include improving muscular strength, decreasing back pain, lowering the risk of gestational diabetes and other pregnancy complications, preventing excess weight gain, and reducing edema in the lower extremities. A full list of the established and likely potential benefits of physical activity during pregnancy on mental and physical health, labor and delivery, and birth outcomes are displayed in Figure 1 [3]. For example, in a meta-analysis of physical activity and its association with gestational diabetes, there was a statistically significant decrease in the risk of gestational diabetes in women obtaining 150-300 minutes per week of moderate-intensity physical activity. Compared to women reporting no physical activity before or during pregnancy, women performing higher levels of physical activity during pregnancy had a 20% decrease in their risk of gestational diabetes, and women who were physically active before and during pregnancy had a 59% lower risk [16]. The same meta-analyses found strong evidence that physically active women were 18%-23% less likely to exceed recommendations for a healthy weight gain during pregnancy. Strong evidence also indicated significantly fewer symptoms for post-partum depression among

active women as compared to their non-active counterparts[16]. Additional benefits of physical activity during pregnancy can be seen in Figure 1.

Figure 1. Benefits of Exercise During Pregnancy

2.4 Current Physical Activity Habits of Pregnant Women

Though physical activity during pregnancy is recommended and has many evidence-based benefits for both the mother and the baby, not all women achieve exercise at the recommended levels. Participation rates in adequate levels of physical activity are low and decrease as pregnancy progresses, with pregnant women spending, on average, almost 60% of their time sedentary [17]. National estimates in pregnant women show that the prevalence of meeting physical activity recommendations ranges from 16% to 25% [1].

Types of physical activity that women typically engage in are varied and change across pregnancy. One study suggested that the most common forms of physical activity and exercise among a cohort of Dutch pregnant women were bicycling, swimming, and low-impact activities, with the majority of women exercising 1 hour or less per week. The same study found that most women that started their pregnancy participating in low impact activities continued to exercise throughout pregnancy, but those that were involved in high impact activities stopped activity completely later in their pregnancy [18].

A more recent study found similar results regarding modalities of physical activity in American pregnant women [19]. Pregnant women self-reported walking as the most frequent physical activity during each trimester of pregnancy (Table 3). These data suggest that walking is highly feasible and sustainable for pregnant women, as compared to running or jogging, which were shown to decrease with each trimester.

Table 3. Exercise Habits in a Sample of U.S. Women (from Catov et al., 2018)

	6 to < 14 wks (N = 10,016)	16 to < 22 wks (*N* = 9408)	22 to < 30 wks (*N* = 9215)	visits
Walking (3.5)[b]	5364	5554	5390	16,308
Aerobics class/Exercise machines (5.5)	1393	1255	1107	3755
Yoga (3.0)	825	1098	1107	3030
Weight lifting (3.5)	651	624	497	1772
Running(8.0)[b]	697	481	215	1393
Swimming (7.0)	383	350	390	1123
Cycling (7.5)[b]	400	314	197	911
Calisthenics/Home or Gym Exercise (4.0)	277	264	212	753
Hiking/Backpacking (6.5)	154	132	102	388
Dancing (5.0)	148	125	77	350
Gardening (3.8)	117	76	61	254
Stair climbing (6.4)	48	58	52	158
Tennis (7.3)	37	26	11	74
Volleyball (4.0)	42	21	11	74
Judo/Karate/Tae Kwon Do (7.8)	26	21	22	69
Softball/baseball (5.0)	33	22	6	61
Basketball (6.5)	30	15	11	56
Sledding/Tobogganing (7.0)	29	24	2	55
Soccer/Badminton/Racquetball (7.0)	33	12	4	49

[a]Study visits occurred in time according to the gestational age of participants

2.5 Barriers and Facilitators of Physical Activity during Pregnancy

Low rates of participation in physical activity reflect barriers to being physically active during pregnancy. Women who report no exercise during pregnancy state the following barriers (with prevalence of reporting in parenthesis after): tiredness (25.0%), fear (18.1%), lack of information (16.7%), dislike of exercise (16.7%), childcare (13.9%), and busy schedule (9.7%) [3]. Just as there are barriers to physical activity in pregnancy, there are also learned facilitators. With those in mind, we can create an intervention to promote facilitators of and decrease barriers

to physical activity for pregnant women. Barriers and facilitators are commonly described and understood by socioecological levels, i.e., community, interpersonal, and intrapersonal, and are described in these categories below.

On the community level, pregnant women report that there are not enough facilities to accommodate familial exercise options within a reasonable budget [5]. In one study, a participant stated that it is harder when you are pregnant to justify spending money on a gym membership because of the constant stress of finances that come with a new baby. For those who are able to afford a gym membership or fitness classes, women express concern that they would not have consistent childcare. The women from the same study mention that the option of group exercise classes specifically for pregnant women would facilitate more common exercise as it is a way to overcome feelings of insecurity and self-consciousness [5].

Interpersonal facilitators and barriers to physical activity in pregnant women have to do with relationships and communication with other people. Social support for physical activity from family and friends (described in detail in section 2.6 below) is one of the most common facilitators and will be a target of the proposed intervention. Information delivered to the women regarding physical activity during pregnancy is also a concern. In one study, pregnant women expressed that they were concerned about certain exercises harming their baby, and that the information delivered to them may have been outdated [6].

The final level to consider is the intrapersonal level. This includes barriers and facilitators that are personal and do not involve other people, such as earlier life experiences or beliefs. For example, in one study, pregnant women reported that the knowledge of benefits of physical activity was not a strong facilitator [6]. A more powerful facilitator among a group of non-Latina White women was the opportunity to get outside of the house. Another study using phone interviews in

1,500 pregnant women and focus groups in 58 women reported on the barriers to physical activity. This study found that eighty-five percent of these women reported an intrapersonal barrier, with two thirds of these being health related [4]. Some other common intrapersonal barriers to physical activity during pregnancy were lack of time, lack of sleep, discomfort, and concern for the baby. Further, as pregnancy progresses, the body changes drastically and rapidly. Many women report avoiding physical activity because it is no longer comfortable. This reported discomfort may reflect physiological changes during pregnancy that can increase perceived and actual exertion. For example, minute ventilation increases up to 50% during exercise due to an increased tidal volume in pregnant women. Because of the decrease in reserve volume, the difficulty to access available oxygen for anerobic and aerobic exercise lags. Women with excessive gestational weight gain may be especially affected by this phenomenon, making strenuous activity difficult [13].

When women were asked for intervention ideas to aid in increasing physical activity during pregnancy, the most common recommendations were across socioecological levels and included to increase social support, provide childcare, and make changes to their work environment that could encourage activity [4]. Observations from the previous studies above suggest that an intervention that is low touch (with minimal participant burden) and with the goal of generally increasing steps throughout the day is an intervention target that could be achieved through low cost activities with children incorporated (e.g., pushing a stroller) may facilitate increased physical activity. Providing social support and trusted, accurate information about safety and recommended physical activity during pregnancy could also facilitate greater participant engagement.

2.6 Social Support for Physical Activity during Pregnancy

Social media platforms are increasingly popular. For example, there are currently over 1.5 billion Facebook users making it the most common platform used by parents in the U.S. [20]. In a study of parents and the use of social media, researchers found that 74% of parents used Facebook and 12% of those logged on daily [21]. Another study by Harpel found that younger parents (<40 years) are more likely than older parents to use social media for support, and first time pregnant women used social media for support more often than multiparous women [20]. With the popularity and accessibility of social media increasing, it may be a helpful delivery tool for interventions seeking to increase in social support and physical activity among pregnant women [22, 23].

As stated in section 2.5, a common interpersonal barrier to physical activity is a lack of social support [3]. In one 2009 study on barriers and facilitators of physical activity in pregnant Latina and non-Latina White women, researchers found that social support was one of the most powerful and third most frequently mentioned facilitator of exercise in their population of pregnant women[6]. Women focused on the desire for support from not only family, but particularly wanted a support system including other pregnant women that they could talk to about their thoughts and feelings throughout pregnancy. Adams, et.al.(2009) , found that women with social support were more likely to change unhealthy habits and learn to develop healthier ones [24]. During this same time, Cavallo et. al.(2012), conducted a study to determine if combining education, physical activity monitoring, and social media networking could increase social support for physical activity. This design used female undergraduate students at a public university and randomized them to two groups: an education group with enrollment in a Facebook group or education only controls. Although this study was not able to find differences in perceived social support or

physical activity over time, it did find that Facebook is a feasible platform for interventions with younger women. This study also showed higher rates of participation in social support than other studies. Thus, to encourage physical activity in pregnant women, it is possible that the support from family, friends, and other pregnant women needs to increase, suggesting social support for physical activity as an intervention target.

Lastly, the Moms2B study implemented a social support group for pregnant women in an impoverished area. By using visual aids and discussing a specific topic each week, the support group was able to retain most of their pregnant women for the current pregnancy, and for future pregnancies as well [25]. A former pregnant woman that participated in the study stated "The Moms2B program has consistently given me a chance to bond and interact with mothers within my community. Even after a year, I still look forward to Moms2B every week. I know that each session will provide me with new information and resources to grow as a mother," [25]. This study provides data suggesting that the use of visual aids and specific topics may help with the implementation and retention of an intervention targeting an increase in social support.

Taken together, social support appears to be an important intervention target in pregnant women. Online social support is a growing platform for health interventions with the goal of increasing physical activity, and Facebook has useful features that could facilitate increasing social support and physical activity by using visual aids, sharing personal and general information by posting, and connecting with other currently pregnant users in real time.

2.7 Summary and Synthesis

Physical activity recommendations for pregnant women are well established, but recent estimates suggest that three out of four pregnant women do not meet current physical activity guidelines [4]. Many studies have reported intrapersonal, interpersonal, and community barriers holding pregnant women back from achieving physical activity goals. Many of the barriers to physical activity during their pregnancy have to do with lack of time, motivation, or convenience, the lack of information about the safety of physical activity during pregnancy, and a lack of social support from friends, family, and other pregnant women. On the other hand, common facilitators of physical activity during pregnancy include increased social support and convenient physical activities. With the increase in the popularity of social media among women of childbearing age, there is reason to believe that social media may be a unique and effective tool to deliver a physical activity intervention.

Despite the substantial research regarding the barriers to physical activity in pregnant women, gaps are present regarding interventions that address some of these well-documented barriers. Specifically, pregnant women are asking for more information from experts on how to safely be active, want more realistic and accessible options to assist in meeting activity goals, and need more social support during their pregnancy, including other pregnant women. Evidence shows that social media is reaching women of child-bearing ages, but there is limited research that delivers physical activity interventions using social media. Using a social media platform as an intervention tool could decrease cost, increase accessibility, and have the ability to reach more participants. Most physical activity interventions for pregnant women have high participant burden, with multiple activity monitors and frequent self-reporting of activity levels. With women already stating a lack of time as a common barrier to their exercise, there is a need for more low

touch interventions among pregnant women. Previous physical activity intervention studies in pregnant women have noted that wearing monitors and following complex protocols during the intervention was difficult for participants [4]. As such, using a single wrist worn device may be the most comfortable activity tracker for participants. Taken together, building a physical activity and social support intervention through a social media platform such as Facebook and with goals to increase steps across the day could be a highly feasible, acceptable, and enjoyable method for pregnant women to increase physical activity habits throughout their day.

3.0 Study Methods

3.1 Study Design

To address our study aims, we completed an experimental, 8-week study with one group (n=10) using a pre-post design. This design was appropriate for our research objectives, which were to measure the preliminary effects of a social media intervention to increase facilitators of physical activity and daily steps for pregnant women. We also decided upon this study design because it allowed us to gather data on the acceptability of the intervention. Together, the information gathered from this small pilot study can be used to inform the design of a larger trial using social media to increase physical activity in pregnant women.

3.2 Participants

A convenience sampling technique was used to find pregnant women for a pilot study from the population. Potential participants were recruited through an advertisement posted on Facebook in different mom groups and in prenatal clinics with flyers and brochures. We recruited 10 pregnant women in the Pittsburgh area that met the eligibility criteria listed in Table 4.

Table 4. Eligibility Criteria

Inclusion Criteria	Exclusion Criteria
Between 12 and 20 weeks pregnant	Diagnosed lung or heart disease
18-45 years of age	Cerclage
Have a personal Facebook account or willing to create one	Multiple gestation pregnancy
Currently achieving <150 minutes of moderate intensity aerobic exercise per week by self-report	Placenta previa after 26 weeks of pregnancy
Provide informed consent	Preeclampsia
Routinely receive prenatal care	Severe anemia
	Vaginal bleeding
	Premature labor during the current pregnancy
	Any limitations to physical activity from the prenatal care provider
	Other significant medical condition that could limit appropriateness of increasing physical activity

To be eligible for this study, pregnant women had to have gestational ages with a low chance of a miscarriage but were well before term (i.e., 37-40 weeks) to allow time for the 8-week intervention. Therefore, we required participants to have gestational ages between 12-20 weeks. The eligibility criteria for age range was 18-45 years. Eighteen was chosen as the minimum because the participant could independently provide informed consent and is considered a legal adult. Forty-five was chosen as the maximum age to limit contraindications and pregnancy complications due to advanced maternal age. Women also had to self-report that they did not currently achieve the recommended level of physical activity (<150 minutes per week of moderate intensity aerobic activity). This criterion reflects the target population for an intervention to increase the physical activity in pregnant women. Because this physical activity intervention was completed over the social media platform Facebook, we required that all participants either had a personal Facebook account or were willing to create one. Lastly, it was important for the women

who were receiving prenatal care to continue to receive prenatal care throughout their pregnancy and the study for safety reasons.

The exclusion criteria listed in Table 4 were selected in accordance with contraindications to exercise and physical activity during pregnancy by ACOG [26]. Because we implemented a minimally supervised intervention to increase physical activity and exercise in pregnant women, we restricted our population to low risk pregnancies that do not require supervision for or medical clearances prior to engaging in a physical activity intervention. Women who had other significant medical conditions or who had been prescribed physical activity limitations from their prenatal care provider were not eligible for this study.

3.3 Intervention

The purpose of this intervention was to increase physical activity in pregnant women with a translatable, low-touch, social media approach that addressed barriers to physical activity and facilitated social support from other pregnant women. As such, there was limited contact from the investigators and the intervention was conducted exclusively through a virtual platform. The platform for this intervention was a private Facebook group that included the participants and investigators. In addition, all participants used a study-provided Fitbit to monitor their daily steps and active minutes during the intervention period.

Prior to beginning the intervention, all women were asked to sign a contract agreeing to appropriate conduct in the private Facebook group. By signing this form, participants agreed to be respectful of the other women in this study, their views, and choices made during their pregnancy. Bullying of other members was not tolerated and was monitored by the interventionist facilitating

the Facebook page. This group was used only as a way for women to interact and support each other throughout their pregnancy and was not intended for the sale of goods and services, discussion of non-study related topics (e.g., politics, personal views, etc.), invading other participants' privacy, or bullying and hate speech. The participants were informed that the first violation of this agreement would result in a warning of misconduct, followed by immediate removal from the Facebook group if there was a reoccurrence.

During the first week of the intervention, enrolled women were asked to join the private Facebook group. The first post was an introduction post from the interventionist. This included a short, 3-minute, welcome video explaining the goals for the Facebook group, physical activity guidelines, and some benefits and strategies for increasing physical activity during pregnancy. There was also a written description of the Facebook group's intended use under the "about" tab at the top of the page along with a shortened version of the agreement policy.

Starting on day 1 of the intervention, the investigators created and published a post for the participants and continued to do so at approximately 9:00 AM every Monday, Wednesday, and Friday for the duration of the 8-week intervention. In line with our specific aims, we used a three-category system for our intervention posts to address specific behavioral constructs including "engage, inform, and support". All posts were related in some way to physical activity and pregnancy. "Engage" posts were used to involve the women in the group encouraging interaction through polls and questionnaires with the purpose of building community, sharing ideas, and increasing participation [27]. The first post asked women to introduce themselves, share their due date, how they like to be physically active, and to state what they wanted to learn from this study or their motivation for joining the study. "Inform" posts included information useful to the participants for increasing their physical activity during pregnancy and were intended to increase

motivation, improve outcome expectations, and reduce fear/misinformation regarding the safety of physical activity during pregnancy. Inform posts reflected previously expressed preferences of pregnant women to include specific guidance for physical activity in pregnancy [7]. All information shared was supported by previous research and accredited organizations. The "support" category included posts intended to encourage participants to reach out and interact with each other [28]. The intervention was intended to foster comradery and social support by encouraging women to like, comment, and post in the group. Example engage, inform, and support posts are presented in Table 5.

Once the informed consent and Facebook agreement were signed, the participant was officially enrolled in the study and introduced to the Facebook group. The study provided-Fitbit was then set up with each participants' specific credentials and mailed to their home address with a letter welcoming them to the study. The women were told that the interventionist would be in touch over the next few weeks once all women were enrolled in the study to invite them to the Facebook group and begin the intervention. Throughout the intervention, the interventionist checked on the Facebook group page twice each weekday (once in the morning and once in the afternoon/evening) to answer any questions, monitor for misconduct of the group, and model, encourage, and assess interaction of participants. While, the primary intent of the interventionist was to encourage social support among participants (rather than directly form the interventionist), the interventionist also provided evidence-based answers to questions around physical activity and lifestyle when prompted by women in the study.

Table 5. Interventionist Post Category Descriptions and Examples

	Engage	Inform	Support
Description of Posts	Ask about goals, progress, and setbacks Facebook discussion boards related to specific exercises 'Icebreaker" questions	Post infographics, videos, and articles related to exercise and pregnancy ACOG and ACSM guidelines to exercise during pregnancy	Pictures and cartoons of relatable pregnancy situations Ask participants to post challenges and seek support Posts of encouragement about how far they have come and what they are to gain from this experience
Specific Examples	What strategies have helped you to increase your steps?	Check out this video of safe and easy stretches to do during pregnancy!	4 weeks down, 4 to go! I have seen so much progress on this page - keep it up!
	What's you step goal for this upcoming week? Try adding at least 500 per day to last week's average!	Do you have any questions about exercising while pregnant during this 8-week study? Ask the experts here!	Who is your main source of support during this pregnancy? If you would like, share a photo below!
	Post a #Selfie of you getting in some physical activity for the day with #GetItIn	Check out this article on how to overcome common barriers to physical activity during pregnancy!	What is the best way that your friends and family have helped you be active during your pregnancy

3.4 Assessments

This study assessed if a low-touch, social media support group delivered on Facebook for pregnant women could reduce barriers to physical activity, increase physical activity, and was acceptable and enjoyable to women during their pregnancy. The assessments were distributed according to the timeline below in Table 6. Questionnaire assessments were conducted

electronically through the Research Electronic Data Capture (REDCap) platform and objective activity data was captured through monitoring via a shared Fitbit account.

Table 6. Assessment Timeline

Assessment	Week #								
	0	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Outcome Expectations & Barriers Questionnaire	X								X
Social Support & Exercise Questionnaire	X								X
Pregnancy Physical Activity Questionnaire	X								X
Objective steps and physical activity (Fitbit)	X	X	X	X	X	X	X	X	X
Facebook Intensity Scale	X								X
Enjoyment & Acceptability Survey									X
Program Evaluation									X

The assessments measured changes in intervention targets, including outcome expectations and barriers to physical activity and social support for exercise from the beginning (baseline) to the end (week 8) of the intervention. The "Outcome Expectations and Barriers Questionnaire" is a validated instrument that uses Likert scales (1-5) to assess agreement reasons and perceived benefits as well as facilitators and barriers for their physical activity habits [29]. The "Social Support and Exercise Questionnaire" assesses social supports that help or hinder women regarding meeting physical activity goals [30]. This validated instrument asks participants to recall how often someone in their household, family, or friends has encouraged them to do something (i.e. exercise, walk, sit down, avoid exercise). The responses include "never, rarely, a few times, often, very often, or N/A." These first two questionnaires were used to address our first specific aim that assessed whether our intervention would reduce barriers to physical activity by increasing social support, motivation, and outcome expectations for physical activity,

To address our second specific aim that tested whether our intervention would increase physical activity among pregnant women, we measured physical activity by a self-report

questionnaire designed specifically for pregnant women (at baseline and 8-weeks) and by using an objective, Fitbit activity monitor (across all weeks of the intervention). The "Pregnancy Physical Activity Questionnaire" (PPAQ) is a validated questionnaire that measures the time participants spend sedentary (<1.5 METs), in light physical activity (1.5<3.0 METs), in moderate physical activity (3.0 - 6.0 METs), and in vigorous physical activity (>6.0 METs), by intensity [31]. Type of activity (e.g., household/caregiving, occupational activity, sports/exercise) was also considered. The second assessment tool to address this aim was a Fitbit, which has been validated for measuring steps in previous research studies [32]. Fitbits were provided to all participants at the beginning of the study (week 0) before the intervention began. They were able to start using the Fitbit before the intervention started (as soon as they were enrolled, following baseline assessments) to get used to the features and, if timing allowed, obtain a baseline step activity of active minutes (i.e., moderate-to-vigorous intensity physical activity) and steps per day. Participants were instructed to wear the Fitbit through the intervention period (weeks 1-8) during all waking hours. To join the study, participants were required to consent to wearing the study-provided device regardless of other devices previously worn and agree to sharing their Fitbit account credentials with the intervention team. During the active intervention (weeks 1-8), moderate-to-vigorous intensity activity (MVPA) and daily steps data were abstracted from the online account and averaged across each week through week 8. If the data showed little participation from the women (<1000 steps per day), they were sent a text reminder to wear the Fitbit and activity from days with <1000 steps was not counted as valid [33, 34] . If there were more than 3 consecutive days with less than 1000 steps, the interventionist contacted the participant reminding them of the importance of wearing the Fitbit and to once again continue to

wear the monitor. However, compliance was excellent and these reminders were not necessary. Participants were given the Fitbit to keep as compensation for completing the study.

Participants also completed a "Facebook Intensity Scale" that assessed typical use of Facebook for connection to others and the site[35]. This questionnaire measured how important Facebook was to the women at this stage in their life, whether that had any impact on how they interacted in the group during the intervention, and if women increased their use of Facebook across the intervention period. Questions in this survey used a Likert scale of 1-5 ranging from "not likely at all" to "very likely" or "strongly disagree" to "strongly agree."

Lastly, participants completed an investigator-developed surveys about overall enjoyment and acceptability as well as a program evaluation of the intervention (week 8). The enjoyment and acceptability questionnaire asked participants what they liked and disliked, what they would change, and their overall impression of a social media intervention. These questions assessed overall opinions on the study's intervention style, posts, and interaction of the group. We assessed whether posts were helpful or relatable, reasons for interacting or not interacting with the site and other users, and specific opinions about each category (engage, inform, support), types of posts (i.e. polls, surveys, infographics, articles, etc.) and the frequency of posting. These data will be used to understand the participants experience and to optimize strategies for future interventions.

3.5 Sample Size

A sample size of ten subjects was selected as an appropriate pilot size to assess preliminary effects of the intervention and gather information about acceptability and feasibility. Data from this study will inform a future study that will have enough power to detect significant effects.

3.6 Statistics

Statistical analyses were performed using STATA version 17.0. Information was summarized using descriptive statics such as means (SD), frequency counts, and percentages. Statistical analyses are listed below after each aim.

Aim 1. Evaluate the effect of a low-touch, social media physical activity intervention in pregnant women on social support, barriers, and outcome expectations over eight weeks

Hypothesis. The intervention will increase social support, decrease barriers, and improve outcome expectations with respect to physical activity.

Questionnaires were scored according to the published algorithms. Changes in these quantitative data were compared using a paired t-test (comparing baseline to 8-week assessments)

Aim 2. Evaluate the effect of a low-touch, social media physical activity intervention in pregnant women on physical activity over eight weeks

Hypothesis. The intervention will increase objective steps per day and active minutes as well as self-reported moderate-to-vigorous physical activity.

Self-reported physical activity was scored according to the published algorithms. Changes were compared using a paired t-test (comparing baseline to 8-week assessments). Steps per day and active minutes from the Fitbit were averaged during each week. A linear mixed model was used to evaluate whether these objective measures increased within subjects over the course of the intervention.

Aim 3. Assess the acceptability and enjoyment of a low-touch, social media physical activity intervention in pregnant women

Hypothesis: Pregnant women will find the intervention acceptable and enjoyable.

Ratings of agreement or disagreement with statements about the intervention's acceptability and enjoyment were summarized descriptively. Open-ended questionnaires were reviewed for themes and summarized qualitatively.

4.0 Results

4.1 Participants

A total of 16 women were referred from prenatal clinics or Facebook mom groups and completed the STAR Pregnancy screening form. Ten of these women completed baseline assessments. Six women completed the screener but ultimately did not enroll because they were uninterested (n=2) and or were ineligible due to gestational age outside of our eligibility criteria (n=4) (Figure 2).

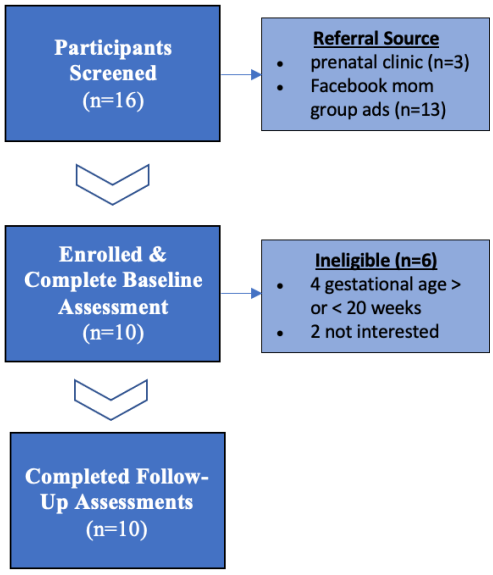

Figure 2 Participant Flow Chart

Participants were, on average, 32 years old, had a gestational age of 17.3 weeks, and had a pre-pregnancy BMI of 26.4 kg/m^2. All women were White and in a committed relationship, with most employed either full-time or part-time (Table 7). None of the women reported currently smoking tobacco or drinking alcohol. Also, no women were previously diagnosed with diabetes

mellitus or hypertension. However, one participant had pregnancy hypertension in a previous pregnancy and two participants previously had gestational diabetes.

Table 7. STAR Pregnancy Participant Characteristics (N=10)

	Mean (SD) or n (%)
Age (years)	32.6 (5.7)
Hispanic or Latino Origin	
No	10 (100)
Yes	0 (0)
Race	
White or Caucasian	10 (100)
Non-white	0 (0)
Highest Education	
High school graduate or G.E.,D Vocational	2 (20)
Some college or Associate degree	2 (20)
College graduate or Baccalaureate degree	4 (40)
Masters or Doctoral Degree (PhD, MD, JD, etc)	2 (20)
Marital Status	
Married or marriage-like relationship	10(100)
Other relationship status	0 (0)
Primary Insurance	
Private	10 (100)
Other	0 (0)
Annual household income	
< $25,000	0 (0)
$25,000 – $99,999	4 (40)
$100,000 - $199,999	5 (50)
Prefer not to answer	1 (10)
Children in household under age 18	
0	3 (30)
1	5 (50)
2	2 (20)
Occupation	
Working full-time	7 (70)
Working part- time	1 (10)
Maternity Leave	1 (10)
Other	1 (10)
Days per week of work	
3 or less	4 (40)
4 or more	6 (60)
Average hours of work	

5 or less	2 (20)
7-8	4 (40)
9 or more	3 (30)
Time Sitting at work	
Almost never	0 (0)
About ¼ of the tie	3 (30)
About ½ of the time	1 (10)
About ¾ of the time	3 (30)
Almost all of the time	3 (30)
Job activities when not sitting	
Standing	5 (50)
Carrying light loads	5 (50)
Carrying moderate to heavy loads	0 (0)
Medical and Reproductive History	
Gestational age (weeks)	17.3 (2.2)
Pre-pregnancy BMI (kg/m^2)	26.4 (5.7)

Though not a specific aim of the study, the Multidimensional Facebook Intensity Scale (MDFIS) was used at the beginning and end of the study to evaluate participants' Facebook use and intensity in four different subscales including persistence, boredom, overuse, and self-expression. No significant differences were observed from baseline to follow-up overall or for any category (all $p>0.05$, see Table 8). While the overall score was the same at baseline and follow-up, three subscales slightly decreased while one subscale slightly increased.

Table 8. Multidimensional Facebook Intensity Scale in STAR Pregnancy Participants

Subscales	Baseline		Follow-up		P-Value
	Mean	SD	Mean	SD	
Persistence	2.9	0.9	2.8	0.9	0.3938
Boredom	3.9	0.8	3.7	1.0	0.1527
Overuse	2.8	0.8	3.0	1.0	0.2848
Self-Expression	2.8	0.6	2.6	0.8	0.2789
Total	2.9	0.6	2.9	0.7	0.6356

4.2 Social Support, Barriers, and Outcome Expectations

The first aim of this study was to evaluate the effects of a low-touch, social media physical activity intervention in pregnant women on social support, barriers, and outcome expectations over 8 weeks. It was hypothesized that the intervention would increase social support, decrease barriers, and improve outcome expectations with respect to physical activity. This aim was assessed through surveys given to the participants at baseline and follow-up.

The first survey was the Social Support and Exercise questionnaire that evaluated perceived support of exercise from family and friends. No significant difference was observed from baseline to follow-up for family (p=0.3014, see Table 9). Though not significant, total social support from family increased from baseline to follow-up by 4.1 points.

Table 9. Social Support (Family) in STAR Pregnancy Participants

Social Support (Family)	Baseline		Follow-up		P-Value
	Mean	SD	Mean	SD	
Positive Support					
Exercised with me	2.4	1.3	3.0	1.3	
Offered to exercise with me	2.5	1.3	3.1	1.3	
Gave me helpful reminders to exercise	2.6	1.0	2.5	1.3	
Gave me encouragement to stick with my exercise program	2.6	1.2	3.2	1.4	
Changed their schedule so we could exercise together	2.1	1.3	2.5	1.4	
Discussed exercise with me	2.6	1.1	2.6	1.3	
Gave me rewards for exercising	1.0	0.0	1.2	0.4	
Planned for exercise on recreational outings	2.0	0.8	2.6	1.3	
Helped plan activities around my exercise	1.8	1.0	2.7	1.3	
Asked me for ideas on how they can get more exercise	1.5	0.9	1.8	1.2	
Talked about how much they like to exercise	2.0	1.1	2.4	1.5	
Negative Support					
Complained about the time I spend exercising	1	0	1.1	0.3	
Criticized me or made fun of me for exercising	1	0	1.3	0.5	
Total Social Support (Family)	21.1	7.2	25.2	9.9	0.3014

Similarly, no significant difference was observed from baseline to follow-up for social support from friends (p=0.3746, see Table 10). Though not significant, total social support from friends increased from baseline to follow-up by 1.7 points.

Table 10. Social Support (Friends) in STAR Pregnancy Participants

Social Support (Friends)	Baseline		Follow-up		P-Value
	Mean	SD	Mean	SD	
Positive Support					
Exercised with me	2.4	1.3	3.0	1.5	
Offered to exercise with me	2.2	1.2	2.9	1.4	
Gave me helpful reminders to exercise	1.7	1.1	1.6	0.8	
Gave me encouragement to stick with my exercise program	1.9	1.3	1.8	1.0	
Changed their schedule so we could exercise together	1.5	0.9	1.8	1.0	
Discussed exercise with me	2.4	1.4	2.5	1.4	
Gave me rewards for exercising	1.0	0.0	1.4	1.0	
Planned for exercise on recreational outings	2.1	1.1	2.4	1.6	
Helped plan activities around my exercise	1.7	1.0	1.8	1.3	
Asked me for ideas on how they can get more exercise	1.5	0.7	1.6	1.1	
Talked about how much they like to exercise	2.4	1.8	2.4	1.5	
Negative Support					
Complained about the time I spend exercising	1	0	1.4	1.0	
Criticized me or made fun of me for exercising	1	0	1.3	0.9	
Total Social Support (Friends)	18.8	7.3	20.5	9.7	0.3746

The second survey was the Exercise Outcomes, Expectations and Barriers questionnaire that evaluates participants' perceived barriers to and benefits of exercise. Subscales for perceived barriers included time, effort, and obstacles, and for outcome expectations included psychological, body image, and health. No significant differences were observed from baseline to follow-up overall or for any category of perceived barriers (all p>0.05, see Table 11). The overall score decreased slightly, which reflected a slight decrease in the effort subscale.

Table 11. Perceived Barriers in STAR Pregnancy Participants

Perceived Barriers Subscales	Baseline		Follow-up		P-Value
	Mean	SD	Mean	SD	
Time Subscale	3.9	1.0	3.9	0.9	1.0000
Too busy	4.0	1.2	4.1	1.1	
Exercise interferes with school	3.6	1.3	3.0	1.3	
Not enough time	4.0	0.9	4.1	1.1	
Effort Subscale	3.3	0.7	3.1	0.6	0.3676
Too Lazy	3.2	1.2	2.8	0.8	
Lack of motivation	3.9	1.0	3.7	0.7	
Too tired	4.4	0.8	3.6	1.1	
Too fatigued by exercise	2.8	0.9	3.0	0.9	
Exercise is boring	2.4	1.2	2.2	0.7	
Too inconvenient	3.0	1.2	2.7	0.7	
Obstacles Subscale	2.9	0.6	3.0	0.6	0.7699
Limiting health reasons	1.8	1.3	1.9	0.6	
Family obligations	3.1	1.7	3.1	1.5	
Bad weather	2.8	0.9	4.2	0.4	
Lack of facilities	4.0	0.9	2.7	1.2	
Total Perceived Barriers	3.3	0.6	3.2	0.6	0.6624

Similarly, no significant differences were observed from baseline to follow-up overall or for any category of outcome expectations (all $p>0.05$, see Table 12). The overall score stayed the same, but a slight increase was observed in the body image subscale while a slight decrease was observed in the psychologic subscale.

Table 12. Exercise Outcome Expectancy in STAR Pregnancy Participants

Exercise Outcome Expectancy Subscales	Baseline		Follow-up		P-Value
	Mean	SD	Mean	SD	
Psychologic Subscale	4.4	0.7	4.1	0.5	0.4260
To help better cope with life's pressures	4.5	0.7	4.6	0.5	
To reduce stress and relax	4.7	0.7	4.4	0.9	
The positive psychological effect	4.8	0.4	4.6	0.7	
For fun and enjoyment	4.2	0.8	4.2	0.4	
Companionship	3.6	1.3	2.9	1.2	
Body Image Subscale*	4.0	0.6	4.2	0.8	0.3005
To lose weight	3.8	1.0	3.9	1.2	
To maintain proper body weight	4.5	0.5	4.4	0.5	
To improve appearance	4.0	0.8	4.2	0.8	
For enhancing self-image and confidence*	3.9	0.9	4.1	1.1	
Health Subscale	4.7	0.3	4.7	0.4	0.6926
Good health	4.8	0.4	4.7	0.5	
To make me feel better in general	4.8	0.4	4.8	0.4	
Stay in shape	4.6	0.5	4.4	0.5	
Total Exercise Outcome Expectations*	4.3	0.4	4.3	0.5	0.9159

*n=9

4.3 Physical Activity Measures

The second aim of this study was to evaluate the effect of a low-touch, social media physical activity intervention in pregnant women on their physical activity over 8 weeks. We hypothesized that the intervention would increase self-reported physical activity as well as objective steps per day and active minutes (MVPA).

The PPAQ measured the amount of time spent in various intensities of physical activities. No significant difference was observed from baseline to follow-up (all $p>0.05$, see Table 13). Though not significant, moderate intensity physical activity increased from baseline to follow-up

by 49.1 minutes per week. It is also notable that average moderate and MVPA were below physical activity guidelines of 150 moderate minutes per week at baseline, but exceeded guidelines at follow-up.

Table 13. Self-Reported Physical Activity in STAR Pregnancy Participants

Subscales	Baseline		Follow-up		P-Value
	Mean	SD	Mean	SD	
Light Physical Activity (minutes per week)	107.5	71.5	109.5	48.1	0.9485
Moderate Physical Activity (minutes per week)	110.1	97.8	159.2	108.9	0.4012
Vigorous Physical Activity (minutes per week)	3.6	5.4	3.7	5.2	0.9888
MVPA	113.7	97.2	162.8	107.4	0.3988

The study-provided Fitbit measured steps and the amount of time spent in MVPA per day (active minutes) for each week of the study. No significant change over time was observed in steps from baseline through the 8 weeks (all p=0.954, see Figure 3). Initially, an increase was observed through week 3, but then steps returned toward baseline levels until the final week.

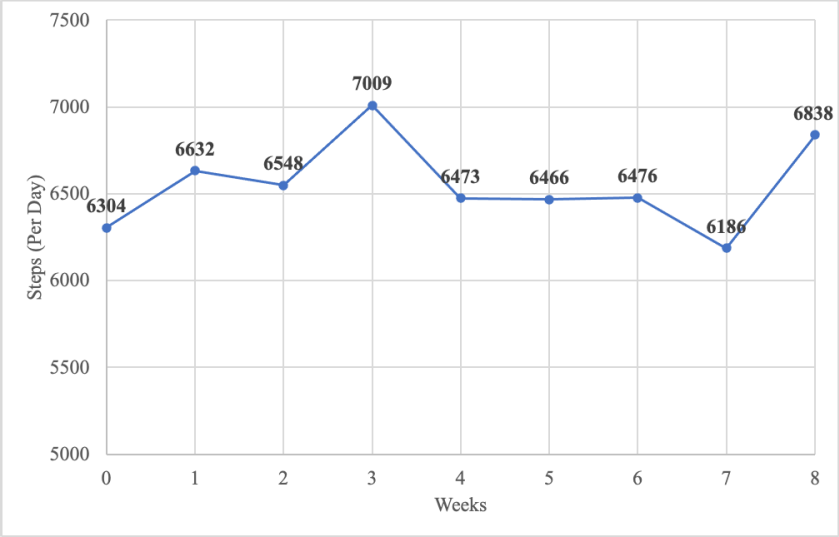

Figure 3. Steps Per Day of STAR Pregnancy Participants

(β (Week)= -2.0 Steps Per Day, p=0.954)

Similarly, no significant change over time was observed in MVPA from baseline through the 8 weeks (all p=0.672, see Figure 4). Again, an increase was observed through week 3, but then MVPA returned toward baseline levels until the final week.

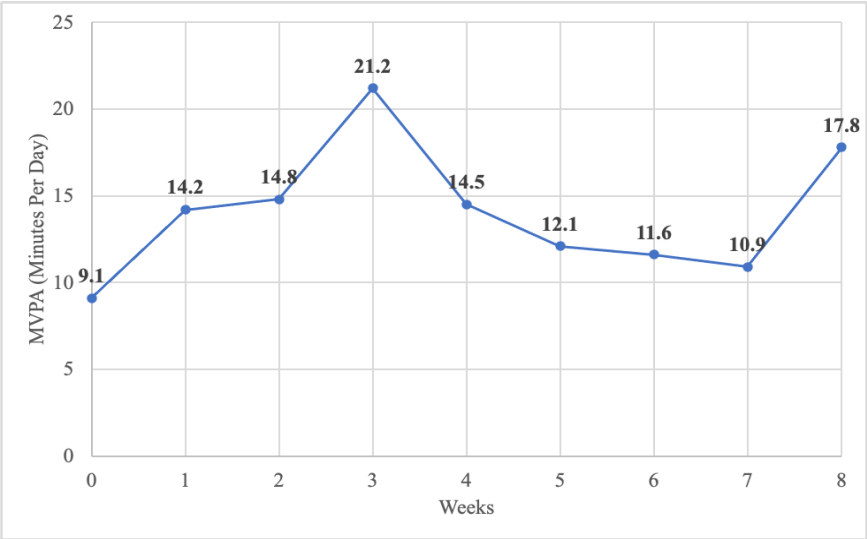

Figure 4. MVPA (Minutes Per Day) of STAR Pregnancy Participants

(β (Week)= -0.1 Minutes Per Day, p=0.672)

4.4 Program Evaluation

The final aim of this study was to assess the acceptability and enjoyment of a low-touch, social media, physical activity intervention in pregnant women through a program evaluation created for this intervention. The first set of questions in the program evaluation assessed the perceived benefits as a result of participating in the intervention. Counts (with a highest possible value of n=10 participants) for each benefit are listed in Table 14 from least to most common. The most common benefit mentioned was feeling healthier and a majority of women reported feeling more focused and productive, while the least common benefit was experiencing less pain.

Table 14. Study Related & Reported Benefits of STAR Pregnancy Participants

Benefit Experienced	Participant Answer Count (of n=10)
Less Pain	1
Reduced Swelling	2
More Energy	3
Less Stress	4
Happier	5
More Focused	6
More Productive	7
Healthier	8

When asked to rate their agreement with the intervention having a positive effect on their pregnancy, 60% of the women agreed, and 80% of the women said that they had a better understanding of the health benefits associated with increasing physical activity during pregnancy.

Next, we asked about the usefulness, enjoyment, and convenience of the Facebook group and Fitbit with averages listed below in Table 15. A rating of 4 indicates most enjoyable, useful, or convenient, while a rating of 1 indicates least enjoyable, useful, or convenient. Participants rated the Fitbit as very useful, enjoyable, and convenient. Participants rated the Facebook page to be less but still somewhat useful, enjoyable, and convenient.

Table 15. Average Ratings of Usefulness, Enjoyment, & Convenience of Intervention Components by STAR Pregnancy Participants

Category	Facebook	Fitbit
Usefulness	2.6	4.0
Enjoyment	3.0	4.0
Convenience	3.0	3.9

Additionally, we explored how the Facebook group was used by the participants and the aspects of the Facebook page that they enjoyed most based on the 3-category posting model described above. Table 16 shows the frequency of answers to the question “how often did

you…something in the Facebook page on average." When asked why someone selected the answer never, most answers were related to being more of a spectator in most groups they are a part of or because they do not use Facebook often.

Table 16. Frequency of Facebook Interactions in the Star Pregnancy Participants

Action	Frequency Count					
	More than once per day	Daily	Weekly	Monthly	Only when directed	Never
Log in	0	0	10	0	0	0
"Like"	0	0	8	1	1	0
Comment on	0	0	5	4	1	0
Interact with another participant	0	0	3	3	2	2
Create a post	0	0	1	2	2	5

For enhanced information of the acceptability of types of posts from the 3-category model mentioned above, we asked participants to rank the different types of posts with respect to enjoyment and influence on physical activity (Table 17). The posts with the lowest enjoyment were engage, though 6/10 people stated they did not have a least favorite. Engage posts were also rated the most enjoyable, again with 4/10 people reporting that they enjoyed all posts equally. The posts with the greatest influence on physical activity were inform posts, and the posts the least influence on physical activity were engage posts.

Table 17. Facebook Post PA & Enjoyment Influence on STAR Pregnancy Participants

Question	Participant Count			
	Inform	Engage	Support	Enjoyed all Posts Equally
What type of post was most enjoyable?	1	3	2	4
What type of post increased your PA the most?	5	1	2	2
TOTAL	6	4	4	6
What type of post was the least enjoyable?	0	3	1	6
What type of post increased your PA the least?	1	4	1	4
TOTAL	1	7	1	10

The program evaluation also asked women to report positive influences on the physical activity behavior that were not related to the study. Two women stated that they were younger or that their friends, who were also pregnant, were physically active, and this may have positively influenced their MVPA. Some common negative factors (barriers to physical activity) outside of the study reported by women included feeling sick and the weather.

5.0 Chapter 5 Discussion

The STAR Pregnancy study evaluated the preliminary effects, feasibility, and acceptability of an 8-week, low-touch social media physical activity intervention among 10 pregnant women. We successfully enrolled 10 participants and all women completed the 8-week study. Although there were no statistically significant changes in our hypothesized outcomes over the 8-week study, we did observe potentially meaningful increases in social support and self-reported MVPA. We also collected meaningful information about the acceptability of components of the intervention (the study-provided Fitbit and private Facebook group) with the program evaluation. The Fitbit was widely accepted and enjoyed by participants. While the Facebook group was somewhat accepted and enjoyed, it was not considered as impactful as the Fitbit by participants. In summary, this study demonstrated feasibility and potential effectiveness for a low touch intervention to increase physical activity in pregnant women and provides information to improve future interventions in this population.

In our first aim, we hypothesized that the intervention would increase social support, decrease barriers, and improve outcome expectations with respect to physical activity. Although there were no statistically significant differences, possibly meaningful increases in social support were observed especially in support from family. This was an unexpected outcome because we had hypothesized that social support from friends would increase through participation in the Facebook group. While the exact reasons for our findings are unknown, we can speculate that participation in the study could have allowed the women to discuss the information and experiences in the study with family members, resulting in an increase in familial social support. In future interventions, more direct prompting to engage with friends for social support may be

more effective to increase friends' social support. Further, we enrolled a convenience sample without requiring women to belong to a specific geographic or social community. Enrolling women that had previous friendship or familiarity or who lived geographically close to each other may have fostered a greater increase in social support from friends.

Additionally, perceived barriers were examined from baseline to follow-up in this study. Addressing barriers to exercise in pregnant women was important when developing this intervention, specifically lack of motivation, lack of facilities, and inconvenience. Although there were no statistically significant changes, some potentially meaningful results would include the slight decreases in lack of motivation by 0.2 points and inconvenience by 0.3 points. A larger decrease from baseline to follow-up occurred in lack of facilities by 1.3 points. These results were expected as we delivered information to the participants on how to get physically active in convenient ways (such as walking more, anywhere) and without the use of specific facilities. An unexpected result was an increase of barriers due to weather by 1.4 points which affected the overall score. We can speculate that the bad weather during some weeks of the study was a barrier for women to walk outside as we instructed them, and this may further have impacted overall steps and active minutes. Future interventions could include more resources/information on creative ways to get steps and physical activity indoors. This may help to decrease obstacle barriers during all seasons. Also, if this study had included a comparison group, we may have been able to see if women in our intervention stayed more active despite the weather barrier and progression of pregnancy.

While we were hoping to increase outcome expectations with the intervention, they did not change from baseline to follow-up. While we do not know the exact reason, the high outcome expectancy score at baseline, when women joined the study, did not leave much room for

improvement. Also, the convenience sample gathered for this study consisted of highly educated women that were interested in getting more active. These women likely had more knowledge about physical activity in pregnancy and better access to health care and information. The intervention results on outcome expectancy could have differed if a more diverse and less motivated or informed sample of pregnant women were prescribed our physical activity intervention instead of the convenience sample we enrolled.

In our second aim, we hypothesized that the intervention would increase objective steps per day and active minutes as well as self-reported MVPA. Although there was no significant change over time observed in steps from baseline across the 8 weeks, we did see an increase in steps per day through week 3, but steps then returned to baseline levels. During the final week, there was an increase in steps once more. A similar pattern occurred with objectively-measured active minutes (MVPA). While the results were unexpected, considering we hypothesized a continued increase over the 8-week intervention, we can speculate that steps and MVPA may not have increased significantly because MVPA and steps tend to decrease as pregnancy progresses and women experienced an increase in weather-related barriers to walking. Future interventions over a longer period of time (across all of pregnancy) and employing a control group as a comparison will be informative for understanding the true effect of interventions like this.

The second way that we assessed MVPA in our participants was through the PPAQ, which showed no significant change over time in self-reported MVPA. Although there were no statistically significant differences from baseline to 8 weeks, participants were able to increase their minutes of physical activity per week across all intensity categories, and especially for moderate intensity activity (the target of our intervention). The most promising finding from the PPAQ shows the average participant did not achieve physical activity guidelines at baseline, but

surpassed guidelines at the 8-week follow-up. This result is consistent with our hypothesis as our intervention sought to provide participants with the tools that they needed to increase their physical activity in pregnancy.

Future interventions may want to employ more direct feedback to participants, for example by incorporating synchronous or asynchronous health coaching to participants to assist in increasing steps and activity. The STAR Pregnancy Intervention's approach was very low touch and left it up to the women to make goals after an initial welcome video. More direction or information on setting goals and real-time, individual-level positive feedback may be necessary to realize more concrete changes in physical activity habits.

In our third and final aim, we hypothesized that pregnant women would find the intervention acceptable and enjoyable. We assessed these outcomes with a study-specific program evaluation given to participants during their follow-up assessments. The first part of the program evaluation asked participants to identify any benefits that they experienced as a result of their participation in the study. The most common benefit was that they felt healthier, and the least common benefit was that they felt less pain during their pregnancy. Along with these benefits, our participants also commonly identified that they felt happier, were more productive, and were more focused because of the study. These results were expected as these are known benefits of increasing physical activity.

The program evaluation showed that the women rated enjoyment, usefulness, and convenience of the Fitbit very high. This was expected as the Fitbit is popular, commercial product to help individuals objectively-monitor and increase their physical activity. We can speculate that the Fitbit was rated so highly because it is user friendly, can be customized, and easily, passively tracks steps, physical activity, and other health metrics in a highly-developed user-interface. In

regards to future research, we would suggest keeping this method of objective self-monitoring and motivation.

The next aspect assessed in the program evaluation was the enjoyment and acceptability of the private Facebook group. The primary goal of the Facebook group was the delivery of information, to increase social support, and to provide information to reduce barriers and improve outcome expectations among pregnant women. The program evaluation was able to give insight into what the participants liked and did not like about the Facebook group, how enjoyable the group was, and if they perceived that it had an effect on their physical activity. Participants most enjoyed answering engage posts, though many liked all posts equally. We expected that there would be a higher enjoyment of the engage posts because they could interact and start conversations through the comments of these posts. Within the Facebook group, there was a higher instance of "liking" and commenting on these types of posts. We also found, as expected, that inform posts were perceived to be most related to increasing physical activity, though there was lower interaction with these posts on Facebook. From the results, it seems that the Facebook group and Fitbit were both accepted and enjoyed, but that the Fitbit was more highly rated by participants. It also seems that the types of Facebook posts were rated similarly, with engage posts having the most interaction and the information posts being most helpful in increasing physical activity. Future interventions could focus more on increasing overall engagement in the page and, specifically, increasing the amount of inform posts with the expectation that the participants would get more information on physical activity during pregnancy. These changes could facilitate greater increases in steps and MVPA.

This study had important strengths and limitations. A considerable strength to this study was the low touch approach. With a low touch intervention, we address the limitation of time as a

barrier to physical activity and the intervention could be delivered with low cost to a broad population. The commercially-available Fitbit made it easy for the participants and interventionist to monitor steps and MVPA. Fitbit is a commonly used and validated instrument for measuring steps and MVPA, which strengthens our study's conclusions. Facebook is also free and widely used by women of childbearing age. This study and intervention were also easily accessible as all assessment and intervention procedures were completed through virtual platforms. We used highly validated questionnaires that are known to measure the mechanisms through which we aimed to increase physical activity in our study. We also had excellent follow-up (100%), further strengthening our conclusions.

There were also some limitations to this study. The primary limitation was the lack of a control group, which did not allow us to evaluate whether our intervention was successful compared to women also progressing through pregnancy at the same time that did not receive the intervention. Because we only looked at 8 weeks, we only observed steps and MVPA from late March 2, 2022 through April 26, 2022, and changes in weather could have negatively affected physical activity habits (as reported by participants). Women were also able to enroll between 12 and 20 weeks of pregnancy, leading to variability in gestation and, for all women, progression through pregnancy during the study. Future studies could examine activity across all trimesters of pregnancy and include a control group to understand the influence of changes in weather and pregnancy progression. An additional limitation to be considered was the influence the Fitbit may have had on participants. Because the participants were told to wear the Fitbits all day and that their steps and MVPA were being monitored, this could have had an influence on their activity habits. Participants knowing we were watching their activity could have resulted in the increased physical activity and steps we observed during the final week. A final limitation to this study was

the small sample size. With a larger group, some of the potentially meaningful changes we observed may have become statistically significant. Informed by the findings of this study, future studies should recruit more participants and include a control group.

In conclusion, the STAR Pregnancy study evaluated preliminary effects and acceptability of an 8-week low-touch social media physical activity intervention among 10 pregnant women. Although there were no statistically significant changes in our hypothesized outcomes over the 8-week study, we did observe potentially meaningful increases in social support and self-reported MVPA while collecting information on the acceptability and enjoyment of the intervention components. Although objective steps and MVPA didn't increase significantly across the study, a potentially positive result is that there was no decrease either, which is common as pregnancy progresses. Both components of the intervention (Facebook group and Fitbit) were accepted and enjoyed, though the Fitbit was accepted and enjoyed more. This study was feasible in our sample of pregnant women and gives reason to suggest feasibility in a larger sample. In summary, this study demonstrates preliminary feasibility and effectiveness, acceptability, and enjoyment of a low touch, social media intervention in increasing physical activity in pregnant women and provides helpful information to improve future similar interventions in this population.

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