SAFETY AND EFFICACY OF A VIDEO-BASED PHYSICAL EDUCATION PROGRAM DURING PREGNANCY: A PILOT STUDY

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BACKGROUND: The objective of this study is to report on the safety and efficacy of once-per-week instructional exercises videos during pregnancy in a pilot study.
METHODS: Pregnant women in their second trimester under the care of obstetricians in an academic hospital were enrolled in the exercise group. Participants in the exercise arm received an instructional video and explanation on each physical exercise beginning at 12 weeks gestation, once a week for the following 12 weeks. Each video focused on a clinically recommended exercise to aid musculoskeletal health. Participants were surveyed regarding physical activity, mental health, and general well-being using the PROMIS-10 and Pregnancy Physical Activity Questionnaire [PPAQ] at 0-, 6-, and 12-week time points. A control group of patients was surveyed for comparison at the 6- and 12-week time points. Differences of means between exercise and control groups, and multivariate regressions of the PROMIS-10 and PPAQ outcomes on treatment status, controlling for BMI at 8 weeks gestation and age, were performed to assess the relationship between physical activity education and well-being and exercise indices.
RESULTS: 22 pregnant women were enrolled in the exercise arm and 34 were enrolled in the control groups. Of the 22 women that began the exercise program, 72.7% (16) completed 6 weeks and 45.5% (10) completed all 12 weeks. No adverse events were noted. No significant differences were established between the exercise and control groups for either the PROMIS-10 or PPAQ measures in this pilot study. Compliance was greater for a shorter duration and among women ≥35 years.
CONCLUSION: We found that a weekly instructional exercise videos during pregnancy could be safely administered, with low to moderate compliance amongst participants. This pilot study suggests the potential of pursuing exercise education interventions with a greater number of participants to better understand the role of exercise education during pregnancy.

INTRODUCTION

Exercise during pregnancy has been shown to be associated with many benefits for women and their fetuses. In addition to promoting overall wellness, regular exercise during pregnancy can help maintain a healthy gestational and fetal weight. Exercise has also been associated with the reduction of pregnancy complications including asthma exacerbations, gestational diabetes, and hypertensive disorders or pregnancy.[1-7] Furthermore, there is some evidence that among individuals who exercise there are improved labor outcomes such as lower odds of induced deliveries and decreased duration of active labor.[8,9]

Despite studies demonstrating the positive benefits of exercise among pregnant women and the possible use of exercise to relieve musculoskeletal pain in pregnancy, pregnant women often receive little guidance on the extent and types of exercise that are healthy. Lack of information is associated with high rates of self-reported uncertainty regarding exercise recommendations.[10]

Further, decline in physical activity during pregnancy is commonly reported even among those with high levels of physical activity prior to

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pregnancy. Specifically, in a cross-sectional study of pregnant patients 55% had stopped baseline physical activity in the setting of pregnancy and only 20.1% of participants reported engaging in any physical exercise.[6]

To address the decrease in physical exercise engagement during pregnancy, it is important to understand the barriers identified by pregnant patients. Coll et. al. found in a review of the literature the most common difficulties reported by pregnant women were pregnancy-related symptoms, mother-child safety concerns, and lack of information.[11] Notably, in 85.5% of the studies analyzed by Colle et. al. women report mother-child safety concerns when discussing exercise. In overweight and obese pregnant women specifically Sui et. al. found that pregnancy complications, tiredness, mood, lack of knowledge, and lack of support posed significant challenges to participating in healthy behaviors.[12]

One approach to addressing this issue is employing an exercise prescription.[13, 14] There have been several RCTs that have used exercise prescription to study health outcomes in pregnant women that illustrated their benefit. For example, in an RCT by Niaraki et al., water exercise was found to reduce the level of musculoskeletal pain among pregnant women.[15] Additionally, Colberg et al. demonstrated that providing women with an exercise prescription can help encourage safe increases in physical activity. For sedentary and deconditioned women with gestational diabetes Colberg et al. provided recommendations for gradual progression to moderate-intensity exercise. They found that even moderate improvements in daily movement can provide protective effects against gestational diabetes.[16]

Given these benefits, there remains a need to better understand how exercise can be effectively implemented as a therapeutic intervention during pregnancy. The purpose of this study was to describe the implementation of a digital 12-week exercise program for women during pregnancy and to report on its safety and efficacy in a pilot study. Understanding how participants engage with digital formats may help inform future models that support individualized, accessible, and evidence-based physical activity guidance during pregnancy.

METHODS

This study was approved by the investigators' Institutional Review Board. An evidence-based, 12-week prenatal exercise program was created under the coordinated supervision of an orthopaedic sports medicine specialist, sports physical therapist, and obstetrician and gynecologist who work together in a Women's Sports Medicine Program. The program was designed to be delivered as a digital educational program through weekly instructional videos that were sent to the patients via email.

Patients were recruited through the Department of Obstetrics and Gynecology at Massachusetts General Hospital. Inclusion criteria were females who were at 14.5 weeks gestation +/- 3.5 weeks and between the ages of 18 and 40 carrying a singleton. Exclusion criteria were high risk pregnancies, age under 18 or over 40, non-English-speaking patients, and patients who had conditions or injuries that limited their ability to exercise.

At the time of enrollment, patients were asked to complete the PROMIS Global-10 (PROMIS-10) questionnaire and the Pregnancy Physical Activity Questionnaire (PPAQ). The PROMIS-10 is a 10-item questionnaire that assesses general health related quality of life, physical and mental health, that has shown to be reliable in several types of musculoskeletal conditions[17-19]. Each question is graded on a 5-point Likert scale where higher scores indicate better health-related quality of life. The PPAQ is a validated, self-reported instrument that is designed to assess the frequency and total physical activity reported over the prior 3 months [20]. Respondents are asked to report time spent in 32 different activities, organized into five domains: household/caregiving, occupational, exercise, transportation, and inactivity. Physical activity measured by PPAQ is expressed in metabolic equivalent of task-hours per week (MET hours per week). MET hours per week quantify total weekly physical activity by weighting time spent in different activities by their metabolic intensity, where one MET represents resting metabolic rate. In addition to these two outcome measures, basic demographic information was collected, including age and BMI at 8 weeks gestation.

Patients who were enrolled then received instructional videos via weekly emails for the subsequent 12 weeks. Each week, an explanation of the physiological changes that were occurring based on their weeks of gestation were provided, as

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well as the rationale for exercises to address this. Patients received two exercise videos per week, each with a description of how to perform the exercise, rationale for performing them, as well as a video demonstrating the exercise. Women were asked to perform these exercises daily. The exercises included pelvic floor, core, balance, and lower extremity strengthening exercises that were increasingly challenging as users progressed through the exercise program. Modifications to traditional exercises based on weeks gestation were provided.

At the midpoint of the study (after 6 weeks), as well at the end of study (12 weeks), patients were contacted to complete another set of PROMIS-10 and PPAQ surveys and provide their feedback. Participants were not asked their level of adherence to the exercises. Any complications or adverse events were recorded.

For comparison, the same inclusion and exclusion criteria were used to select two control groups who were at 20.5 weeks gestation +/- 3.5 weeks and 26.5 weeks gestation +/- 3.5 weeks respectively. The 20.5 weeks gestation group was used as the 6 week control and the 26.5 weeks gestation group was used as the 12 week control. PROMIS-10 and PPAQ scores, along with basic demographic data, were collected and recorded for these control groups.

Statistical Analysis

Descriptive data were presented as mean +/- standard deviation. Percentages of program completion were calculated for the exercise group. One way analysis of variance was used to compare PPAQ and PROMIS-10 scores at the 0, 6 week and 12 week points for the exercise group. Additionally, independent t-tests were used to compare means between the control and exercise groups at the 6 and 12 week marks. Subgroup analysis was performed by age group >=35 and <35 years, and by BMI >25 and <=25. Multivariate regression was performed to assess the relationship between PROMIS-10 and PPAQ and exercise instruction while controlling for age and BMI All statistical analysis was completed in R studio (Boston, MA). Significance was set at $p<0.05$.

RESULTS

56 women were included in this study, of which 22 were in the exercise arm and 34 were in the control group. In the exercise group mean age (+/- standard deviation) was 33.3 (4.84) and mean first trimester BMI (+/- standard deviation) was 25.0 (4.84). The 6 week and 12 week control groups had a mean age of 32.2 (2.39) and 32.9 (3.60) and mean first trimester BMI was 23.7 (3.66), and 29.1 (8.21), respectively.

The exercise treatment group began with 22 subjects at the baseline survey while 72.7% and 45.5% of subjects remained after six and twelve weeks. Table 1 demonstrates dropout rates by age and BMI.

Table 1. Dropout rates by age and BMI subgroups at Weeks 6 and 12 in the Exercise Group

Subgroup	*Week 6 Dropout %*	*Week 12 Dropout %*
Age < 35	54.5% (n=6)	72.7% (n=8)
Age ≥ 35	0.0% (n=0)	14.3% (n=1)
BMI ≤ 25	50.0% (n=3)	66.7% (n=4)
BMI > 25	25.0% (n=3)	41.7% (n=5)

Figure 1 displays the mean values of PROMIS-10 and PPAQ among the exercise and control groups. At 6 weeks, the exercise group included 16 participants, with 10 respondents remaining at 12 weeks. The control group included 14 participants at 6 weeks and 20 participants at 12 weeks. The control group values for PROMIS-10 and PPAQ are higher than those for the exercise group at both week 6 (20.5 weeks gestation +/- 3.5 weeks) and week 12 (26.5 weeks gestation +/- 3.5 weeks) (Appendix Table 1). This difference was statistically significant between PROMIS-10 scores at 12 weeks, suggesting that the weekly exercise videos did not necessarily result in better general health outcomes than in the control groups. PPAQ demonstrated no significant differences between the exercise and control groups at both time points. Results of all corresponding t-tests are presented in Appendix Table 2.

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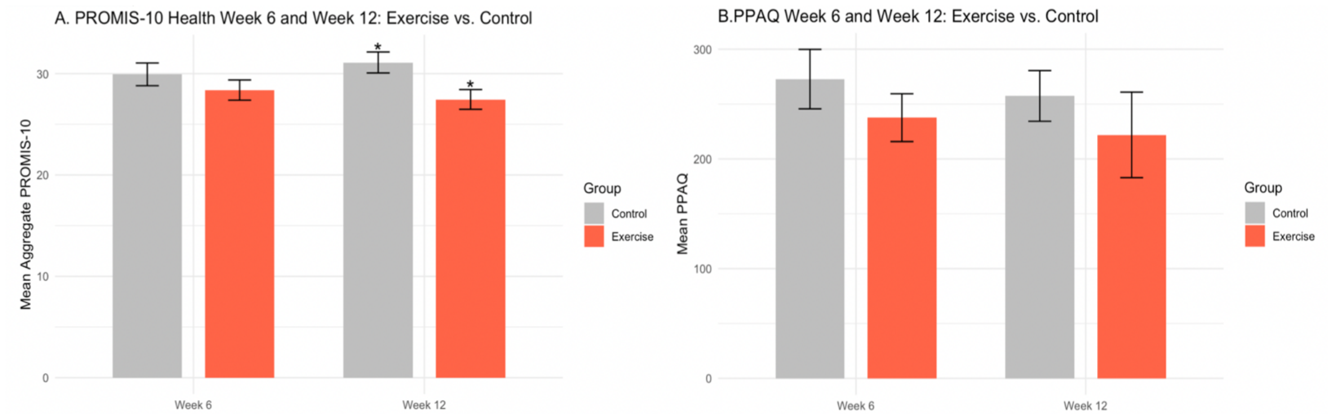

Figure 1. Comparisons of PROMIS-10 (2A) and PPAQ (2B) based on treatment status. The exercise group received instructional videos on different physical activities for the 12 weeks of the study.
*Error bars represent standard error. *p<0.05*

The multivariate regression estimates of PROMIS-10 and PPAQ outcomes on an indicator variable for the exercise treatment controlling for age and BMI are shown in Appendix Table 3. The coefficient estimates in the PROMIS-10 regression for weeks 6 and 12 are negative and statistically significant for week 12, again indicating that weekly exercise videos did not appear to lead to increased activity and well-being outcomes in this pilot study. The analogous coefficient estimates for the PPAQ outcomes in weeks 6 and 12 were not statistically significant.

Within the exercise group, mean PPAQ scores stratified by age and BMI increased relative to baseline, though the differences are not statistically significant (Appendix Table 4). Within-group comparisons of PROMIS-10 scores showed changes in mixed direction, and no statistically significant difference were observed (Appendix Table 5). Lastly, PPAQ scores at week 0 and week 6 and week 12 were compared for the same individual exercise participants. While all comparisons showed increases in PPAQ, but statistical significance was not reached (Appendix Table 6). Trends were mixed for PROMIS-10, which is outlined in Appendix Table 7.

DISCUSSION

The most important finding of our study is that exercise education via a digital platform was found to be safe without complications but was completed only by 45.5% of women primarily in those who are ≥35 years and BMI >25.

Previous studies have supported the benefits of exercise during pregnancy. The American College of Obstetricians and Gynecologists (ACOG) generally recommend all women without significant complications or risk should engage in 150 minutes of weekly moderate-intensity aerobic exercise. RCTs evaluating the safety of different types of exercise including walking, stationary cycling, aerobic exercises, dancing, resistance, stretching exercises, and hydrotherapy have all been found to be safe and even beneficial.[21] Additionally, situations requiring the cessation of exercise during pregnancy such as bedrest and activity restriction, can be detrimental, increasing risk of venous thromboembolism and bone demineralization.[13] While exercise has been shown to be safe and not doing so can be harmful to the pregnant patient compliance with ACOG guidelines is low.

Data from the 2007 and 2014 U.S. population's health, the National Health and Nutrition Examination Survey (NHANES), found that only 12.7% of pregnant patients were completing greater than 150 minutes of moderate-intensity aerobic exercise.[22] In a cross-sectional study using data from the Copenhagen Pregnancy Cohort they found that only 38% met Danish guidelines for exercise during pregnancy. They found that not meeting these guidelines was significantly associated with being a multiparous woman, having a previous miscarriage, and smoking before pregnancy.[23] Our study sought to determine if instructional exercise videos can induce higher rates of exercise among pregnant women. Our results support the previous literature's findings of low exercise rates by

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showing that even among women who self-selected into the exercise education treatment, there was less than 50% compliance to the exercise program after 12 weeks. These findings highlight a persistent challenge in maternal health: even motivated individuals may struggle to maintain consistent exercise behaviors.

ACOG maintains these physical activity guidelines regardless of maternal age. Multiple studies including pregnant women of all ages have found positive impacts of exercise. A RCT performed in Spain randomized three sessions of aerobic exercise a week to pregnant women with a mean age of 31.04 (+/- 3.78) and found significant decrease in risk of excessive maternal weight gain and gestational diabetes.[2] In an observational paper by Haakstad et al., pregnant women older than 35 who exercised two or more times a week experienced positive outcomes such as lower gestational weight gain, but fewer pregnant women older than 35 reported exercising at all compared to those less than 35 in the study.[25] We observed very low dropout rates among women ≥35. Thus, possibly among women ≥35 educational online content promotes consistency in current exercise habits. However, these results were not statistically significant, and no definitive conclusions can be drawn from these findings.

Pregnant patients' BMI also does not change daily exercise recommendations. In an RCT assigning a healthy lifestyle app, which included physical activity suggestions, to pregnant women, women in the intervention arm with overweight and obesity before pregnancy gained less weight compared to the control.[26] Additionally, like with age there have been multiple studies including pregnant women of all BMIs finding benefits to increased physical activity during pregnancy.[2, 15, 24, 33] We did not observe changes in exercise activity among pregnant women with a BMI <= 25 or with a BMI >25 in line with overall findings. While not statistically significant, dropout rates were low among women with higher BMI, providing possible characterization of what population may respond best to online exercise instruction.

In our pilot study, we did not find any significant relationships between physical exercise education and our activity measures, PROMIS-10 and PPAQ, in our bivariate comparisons between the exercise and control groups. Further, multivariate regressions showed no significant positive difference between the exercise and control group, however, BMI and age may not completely account for the difference between the treatment and control groups. We did note some suggestive differences within the exercise treatment group over time. Among the entire exercise intervention group, we observed an increase of 7.8% between 14.5 weeks gestation +/- 3.5 and 6 weeks later which supports our hypothesis that physical exercise education could combat decreases seen in physical activity over pregnancy.[28-29] In a cross-sectional study of 359 pregnant women, Evenson and Wen found that most pregnant women spent more than half of the day in sedentary behaviors when monitored by an accelerometer.[29] Further, Hegaard et. al describe the general decrease in physical activity over the first, second and third trimester.[30] One possible way the exercise videos used in this study could have led to seeing general positive trends, albeit insignificant, is by helping promote self-efficacy among pregnant patients which has been associated with the maintenance of physical activity. Even small increases in confidence or clarity around safe exercise may help stabilize activity levels during a period characterized by predictable declines.[31-32]

Other studies have demonstrated the benefits of exercise in pregnant women, but there remains a lack of knowledge on how physicians can best facilitate healthy exercise habits in their pregnant patients. Further, as Coll et. al highlighted, many women feel unsure of how they can exercise in a way that is safe and beneficial to their health.[11] While this pilot study this study did not find statistically significant increases for those provided with instructional exercise videos, the positive increases over time within the exercise group combined with the small sample in the study suggest it is important that there continues to be research on how structure exercise media may help improve pregnant individual's daily activity and quality of life.

Limitations

This study had some limitations that should be considered. First, we did not track the usage of the exercise or confirm that they were being performed correctly, which may variably influence the effect that these exercises had on individuals. Additionally, we did not assess activity levels or interest in participating in exercise programs, which may impact patients' desires to participate in exercise. Further, the control groups are composed of different individuals for the week 6 and week 12 comparison adding variability to our cohort. Third,

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there is significant missing data and treatment group attrition that should be kept in mind when interpreting the results. Lastly, subjects selected into the treatment group. Therefore, it is possible that those who opted into the treatment group may have had other factors that influenced their responses.

CONCLUSION

We found that a weekly instructional exercise videos during pregnancy could be safely administered, with low to moderate compliance that was greater for a shorter duration. Compliance tended to be higher among participants ≥35 age and >25 BMI. This evidence suggests the potential of pursuing alternative education interventions in larger studies to better understand the role of exercise education during pregnancy.

Conflict of Interest Statement

The authors declare no conflicts of interest with the contents of this study.

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APPENDIX

Table 1. Average PROMIS-10 and PPAQ score for exercise and control groups

	PROMIS-10			***PPAQ (MET hours per week)***		
	0 Weeks	6 Weeks	12 Weeks	0 Weeks	6 Weeks	12 Weeks
Exercise Group	28.2 (n=22)	28.4 (n=16)	27.7 (n=10)	220.5 (n=22)	237.6 (n=16)	221.9 (n=10)
Control Group		29.9 (n=14)	31.1* (n=20)		272.8 (n=14)	257.4 (n=20)

**p<0.05*

Table 2. Between-group differences in PROMIS-10 and PPAQ scores at 6 weeks and 12 weeks

	PROMIS-10			*PPAQ (MET hours per week)*		
	0 Weeks	6 Weeks	12 Weeks	0 Weeks	6 Weeks	12 Weeks
Difference	NA	-1.55	-3.65*	NA	-35.14	-35.50
Two-sided Welch t-test	NA	t=-1.04	t=-2.56	NA	t=1.01	t=0.78
p-value	NA	0.31	0.016	NA	0.322	0.445

**p<0.05*

Table 3. Adjusted Coefficient Estimates of PPAQ and PROMIS-10 Regressions by Exercise Group

	PROMIS-10			***PPAQ (MET hours per week)***		
	0 Weeks	6 Weeks	12 Weeks	0 Weeks	6 Weeks	12 Weeks
Exercise	NA	-1.918 (1.412)	-4.653* (1.721)	NA	-7.203 (30.085)	7.564 (49.040)
Age	NA	0.299 (0.215)	-0.045 (0.228)	NA	-14.580** (4.577)	-9.672 (6.371)
BMI at initial visit	NA	-0.524** (0.173)	-0.234* (0.102)	NA	10.579** (3.688)	2.490 (2.787)

*OLS coefficient estimates for PROMIS-10 and PPAQ regressed on treatment status, age, and BMI at initial prenatal visit with the standard error of each estimate reported in parentheses. *p<0.05, **p<0.01*

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Table 4. Difference of means in PPAQ scores within the exercise group from week 0 to 6 and week 0 to 12 by age and BMI

PPAQ (MET hours per week)

	All Exercise Group		Exercise Group <35 yrs		Exercise Group ≤ 25 BMI	
	Wk 6 v. 0	Wk 12 v 0	Wk 6 v. 0	Wk 12 v. 0	Wk 6 v. 0	Wk 12 v. 0
Difference	17.14	1.42	37.89	39.34	23.21	21.46
Two-sided Welch t-test	t= 0.64	t= 0.04	t= 0.87	t= 0.60	t=0.77	t= 0.569
p-value	p=0.539	p=0.969	p=0.393	p=0.560	p=0.449	p=0.576

Table 5. Difference of means in PROMIS-10 scores within the exercise group from week 0 to 6 and week 0 to 12 by age and BMI

PROMIS-10

	All Exercise Group		Exercise Group <35 yrs		Exercise Group <=25 BMI	
	Wk 6 v. 0	Wk 12 v 0	Wk 6 v. 0	Wk 12 v. 0	Wk 6 v. 0	Wk 12 v. 0
Difference	0.147	-0.527	0.827	-0.673	0.806	-0.467
Two-sided Welch t-test	t= 0.12	t= -0.66	t= 0.46	t= -0.35	t=0.58	t= -0.302
p-value	p=0.899	p=0.513	p=0.649	p=0.730	p=0.565	p=0.7657

Table 6. Comparisons of PPAQ within the exercise group from week 0 to week 6 and week 0 to week 12

PPAQ (MET hours per week)

	All Exercise Group		Exercise Group <35 yrs		Exercise Group ≤ 25 BMI	
	Wk 6 v. 0	Wk 12 v. 0	Wk 6 v. 0	Wk 12 v. 0	Wk 6 v. 0	Wk 12 v. 0
Difference	34.04	32.74	57.14	86.6	33.97	42.43
Paired t-test	t= 1.82	t= 0.81	t= 1.70	t= 0.74	t=1.43	t= 0.569
p-value	p=0.089	p=0.439	p=0.132	p=0.536	p=0.183	p=0.576

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Table 7. Comparisons of PROMIS-10 within the exercise group from week 0 to week 6 and week 0 to week 12

PROMIS-10

	All Exercise Group		Exercise Group <35 yrs		Exercise Group <=25 BMI	
	Wk 6 v 0	Wk 12 v 0	Wk 6 v. 0	Wk 12 v. 0	Wk 6 v. 0	Wk 12 v. 0
Difference	-0.375	-0.636	-0.125	0.500	0.182	-0.500
Paired t-test	t= -0.47	t= -0.72	t= -0.09	t= 0.27	t=0.22	t= -0.47
p-value	p=0.644	p=0.490	p=0.935	p=0.804	p=0.829	p=0.649

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