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Review Article

Psychosocial mediators to physical activity during the perinatal period: A review of the literature

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Abstract

Background: Prenatal physical activity is associated with numerous maternal and child health outcomes. Unfortunately more than half of US women fail to engage in regular exercise during pregnancy. Thus there is a clear need for effective intervention strategies aimed at increasing physical activity among pregnant women. In order to meet this need, the present study provides a systematic review of prospective and intervention studies to identify potential mediators of physical activity during pregnancy.

Methods: A systematic review was conducted searching PubMed, MEDLINE, CINAHL, and PsychINFO for prospective studies published from 1995 through 2012 that examined potential mediators to physical activity as well as any intervention studies that sought to increase physical activity levels during pregnancy. Eleven prospective studies that examined potential mediators to physical activity and 3 intervention studies that aimed to increase physical activity during pregnancy were selected that met the inclusion criteria of this review. Articles were reviewed and discussed according to the population, study design, mediators examined (e.g. beliefs pertaining to perceived benefits, barriers, severity and self-efficacy as well as social support, behavioral skills, subjective norms, and behavioral intention), measured outcomes, results, and conclusions of the studies.

Results: The review identified several significant mediators of perinatal physical activity such as beliefs (e.g. perceived benefits, barriers, severity and self-efficacy toward physical activity), attitudes, social support, and perceived stress, among others.

Conclusions: This review highlights psychosocial mediators that show promise in influencing physical activity behavior. Given that there are very few intervention studies that target these psychosocial mediators more research is warranted in this area.

INTRODUCTION

Recent studies have established numerous benefits to physical activity during pregnancy such as reduced excessive gestational weight gain [1,2], improved course of delivery [3,4], reduced incidence of gestational diabetes mellitus [5], preeclampsia [6], reduced physical discomforts associated with pregnancy [7,8] and many psychological benefits [9,10]. Among women free of obstetric complications, physical activity during pregnancy poses no risk to fetal outcomes, even among women who initiate physical activity at various points during pregnancy [11]. Given this, the American College of Obstetricians and Gynecologists (ACOG) and the Department of Health and Human Services (DHHS) recommend that women free of medical or obstetric complications engage in 30 minutes of physical activity per day approximately 5 days per week or 150 minutes of aerobic activity per week [12,13]. However, many pregnant women do not engage in the recommended amount of weekly physical activity. Less than half of US women report regular exercise during pregnancy and these activity levels often decrease throughout the course of pregnancy with only 30-40% of women in the US gaining the recommended gestational weight advised by the Institute of Medicine (IOM) [14-18]. The significance of this is underscored by the fact that 46 percent of normal weight women, 46 percent of obese women,

and 59 percent of overweight women gain in excess of the IOM recommendations [18]. Taken together this evidence suggests that a sedentary lifestyle contributes to excessive gestational weight gain and failure to lose weight after pregnancy, which are both predictors of long-term obesity [19]. Given the benefits of being active during pregnancy, the current low rates of antenatal physical activity, and the risk of adverse perinatal outcomes; it is evident that pregnancy is a critical time in a woman's life to incorporate physical activity.

Identifying effective ways to increase antenatal physical activity engagement among women in the perinatal period is of utmost importance. In order to guide intervention programs for pregnant women, numerous qualitative studies have been carried out examining the barriers to physical activity to better understand the challenges that women face during pregnancy. Findings from these studies suggest that there are many perceived barriers to antenatal physical activity related to physical discomforts such as nausea, fatigue, shortness of breath, heart burn, leg cramps, and body soreness that prevent them from engaging in physical activity [20-22]. Uncertainty about how to engage in exercise safely [22], concern about injury [23], and perceived limited time [20] are also commonly cited barriers. In addition to examining the barriers, studies have also identified various facilitators to physical activity during pregnancy, such as social support, access to resources and information, weather, community safety, and childcare [20,22,24]. These qualitative findings provide some guidance to the design and implementation of intervention studies. Less is known about what mediates change in physical activity during pregnancy. Mediating variables (i.e. mediators) act as a cause and effect order between an intervention and behavior change and are key change agents for effective intervention planning and implementation [25]. Using prospective studies to follow pregnant women over time and identify which variables were associated with increased physical activity, and determining which mediators have had an impact on antenatal physical activity through intervention studies would help inform future intervention efforts.

In order to address this gap, a systematic review of the literature was conducted to identify theoretically-based psychosocial mediators of physical activity during pregnancy. There are numerous well-established health behavioral theories (e.g. Social Cognitive Model, Transtheoretical Model, Theory of Planned Behavior, among others) that have been shown to effectively change health behaviors such as physical activity [26]. Many of these theoretical frameworks involve mediating variables that can be targeted in interventions to increase physical activity. Although there is ample evidence supporting theoretical-based mediators of physical activity in the general population, less is known about what psychosocial mediators are effective in changing physical activity behavior during pregnancy. Findings from this systematic review will help identify effective change agents of antenatal physical activity by following women over time in prospective cohort studies, and identifying which of these mediators have been applied to current intervention studies. This will in turn, help inform future health behavioral change intervention efforts in enhancing physical activity engagement during pregnancy.

METHOD

Studies included in this review were collected via a comprehensive literature review using the following databases: PubMed, MEDLINE, CINAHL, and PsychINFO. The search was conducted in 2012 using different combinations of the following keywords: exercise, exercise psychology, pregnancy, postpartum, self-efficacy, social support, psychosocial, health behavior, prospective studies, intervention studies, randomized controlled trial, and physical activity. The original search yielded 219 articles in PubMed, 106 articles with PsychINFO, 136 articles with MEDLINE, and 17 articles with CINAHL, for a total of 478 articles. After excluding a total of 227 duplicates, 251 abstracts were reviewed for inclusion criteria.

The review included prospective cohort studies that examined mediators to physical activity and intervention studies that targeted and measured mediators with the aim of increasing physical activity during pregnancy, and met the following inclusion criteria: in English language, involved pregnant women greater than 18 years of age, and were published between 1995 and 2012. The inclusion criteria were selected to include all relevant literature involving adult pregnant women. Some of these articles did not meet the inclusion criteria for various reasons please see Figure 1. For example, 39 articles were excluded because they were not prospective or intervention studies and 32 articles studied a population other than adult pregnant women. Of these 32 studies, the majority were studying women in the postpartum period only, and several studies examined adolescent pregnant women which did not meet the inclusion criteria and were excluded.

The literature review yielded 18 prospective and 11 intervention studies. Upon full review of the text, the following prospective studies were excluded due to following body mass index (BMI) or gestational weight gain (GWG) over time rather than predicting physical

activity levels [27,28], not examining theoretical mediators to physical activity but reporting epidemiologic data on physical activity during pregnancy [29-31], measuring intent to exercise, but not measuring physical activity [32], and assessing predictors of inactivity, rather than following theoretical mediators to increase physical activity [33]. The following intervention studies were excluded upon full text review due to design of an intervention program without physical activity results [34,35], studying pregnant women's adherence to exercise and not increasing the level of activity [36], not measuring physical activity levels as this was not the primary outcome [2,37,38], a structured exercise regimen that did not target mediators to physical activity, rather used an exercise regimen to reduce maternal weight gain [39], and not measuring the mediators to physical activity targeted in the intervention [40]. Therefore, 11 prospective and 3 intervention studies were included in the review.

The 14 articles were then analyzed and compiled in table form assessing the population, study design, mediators examined, measured outcomes, results, and conclusions of the studies. Information included in these tables was limited to findings relevant to the physical activity levels and mediators to physical activity.

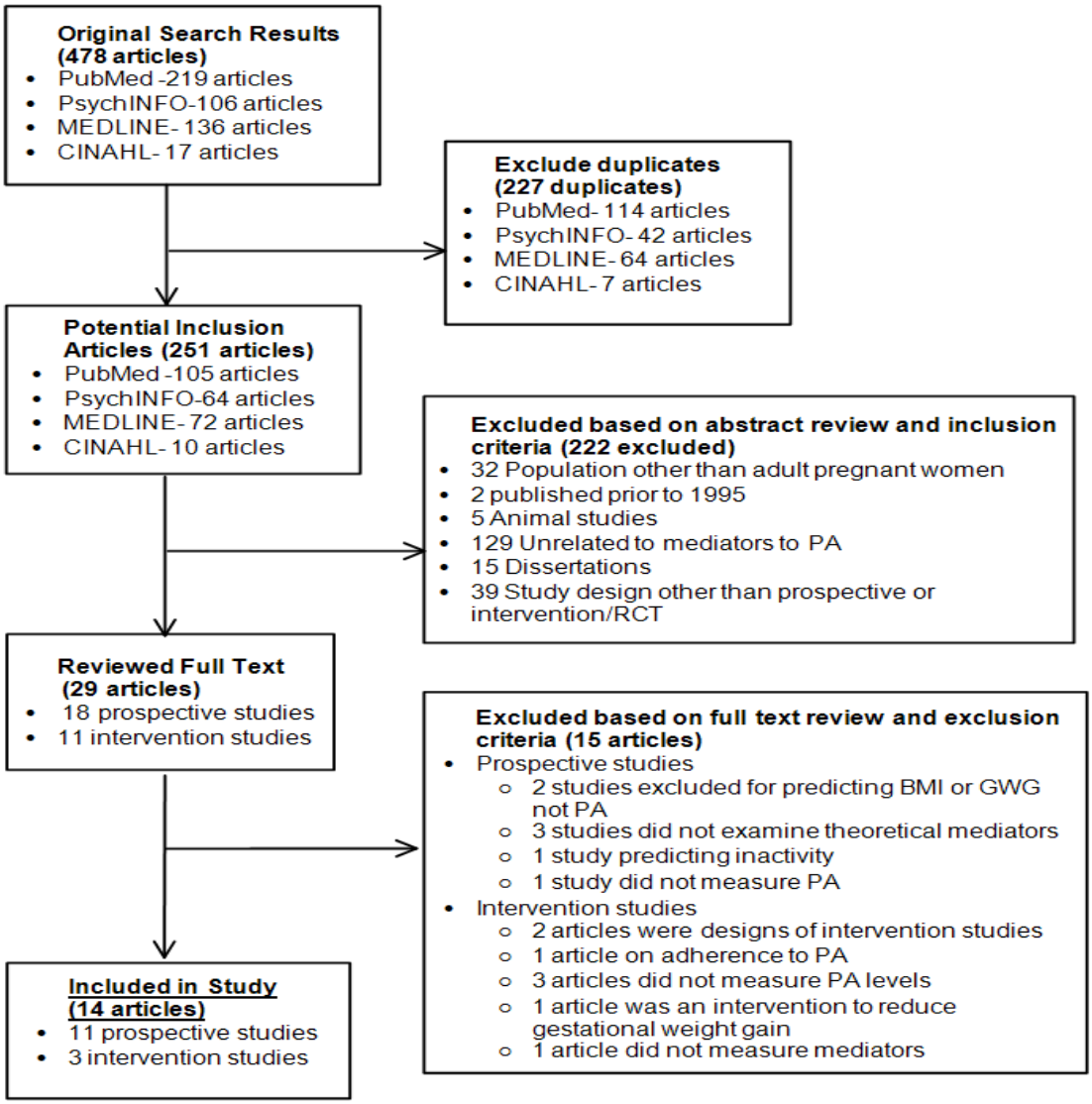

Figure 1. Study Selection Flowchart

RESULTS

For this review, 11 prospective studies and 3 intervention studies met the inclusion criteria were identified. A summary of the studies included and mediators addressed can be seen in Tables 1 and 2.

Prospective Studies

The populations studied in the 11 prospective studies consisted of mainly white, married women in the US, Australia, the UK, and Sweden. Overall, the studies found several significant correlates of exercise behavior including prepregnancy activity level [41,42], age and pre-pregnancy BMI [41] as well as numerous psychosocial mediators. The psychosocial mediators examined in the prospective studies covered several domains including beliefs (e.g. perceived benefits, barriers, severity and self-efficacy), social support, knowledge, subjective norms, and behavioral intention.

The domain of beliefs encompasses mediators such as self-efficacy, perceived benefits, perceived barriers, and body image. Of these mediators, barrier and exercise self-efficacy [41,43,44], perceived behavioral control [45,46] safety concerns [21,47], perceived stress [42], hostility [42], body satisfaction [44], and positive feelings about motherhood [44] were correlates of exercise behavior during the perinatal period. Contrary to Hinton et al. (2001b), body image satisfaction was not associated with increased exercise behavior in perinatal period in two other studies [48,49]. The domains of behavioral intention [37,44-46] and social influences such as social support [42,44], were also found to be mediators of physical activity.

Three out of the eleven prospective studies followed the theory of planned behavior (TPB) for predicting physical activity. Two of these studies demonstrated that behavioral intention and perceived behavioral control had the strongest correlations with exercise behavior [45,46], while the final study found that exercise intention was the only significant predictor of exercise behavior [37]. Attitude [37,45,46], subjective norm [45,46] and perceived behavioral control [37,45] were predictors of exercise intention. In addition to the TPB, two out of the eleven prospective studies followed the Social Cognitive Theory (SCT) [43,44]. Both of these studies found that self-efficacy predicted physical activity. In summary, TPB and SCT were effective models of predicting exercise behavior in the perinatal period.

Intervention Studies

There were a limited number of intervention studies that addressed and measured the mediators to physical activity during pregnancy. These studies examined populations of mainly educated, white participants as well as some Hispanic pregnant women. The interventions were delivered via print, telephone, and face-to-face counseling and followed theoretical frameworks such as Social Cognitive Theory (SCT) [50,51], Transtheoretical Model (TTM) [50], and the Protection Motivation Theory (PMT) [52]. Of the 3 intervention studies, the following mediators were examined: self-efficacy, behavioral and cognitive process of change, decisional balance, perceived vulnerability, perceived severity, response efficacy, goal intention, and implementation intention. Of these studies, Gaston and Pravessis (2009) successfully increased physical activity levels in the PMT intervention group and delivered their intervention via a brochure based on PMT constructs. This study also achieved significant increases in perceived severity, response efficacy, self-efficacy, and goal intention in the PMT intervention group compared to the attention control and noncontact control groups. Chasan-Taber et al. (2011) achieved significant differences in physical activity levels between their intervention and control group. This intervention was delivered the intervention via a printed manual based on the participant's motivational stage and motivational telephone calls monitoring progress and physical activity goals. This study showed successfully increased behavioral process of change compared to the control group, but failed to achieve significant changes in cognitive process of change, self-efficacy, and decisional balance. The intervention study done by Wilkinson et al. (2010) was delivered via an interactive pregnancy pocketbook which included health education materials, screening tools, and self-monitoring activities. This intervention group trended toward increased physical activity, but failed to show significant differences between physical activity in the intervention and control groups. It also failed to achieve significant differences in self-efficacy between the intervention and control groups. Additional results for these intervention studies can be seen in Table 2.

Table 1-1. Prospective Studies Included in Review

Citation	Population Studied	Study Design	Theoretical Mediators	Measured Outcomes	Results	Conclusions
Clarke & Gross (2004)	57 nulliparous, pregnant women in United Kingdom Mean age of 26.3 years 65% Married	Preliminary, prospective survey Assessments: Semi-structured interviews at 16, 25, 34 and 38 weeks	Theory: Knowledge, beliefs, locus of control	PA*: semi-structured interview, Prepregnancy PA assessed by Modified Baecke Questionnaire	36 women (63%) reported that they had ceased or reduced exercising due to physical limitations; 30 women (52%) said they were responding to advice; 18 (32%) referred to risks or dangers that they believed to be associated with activity Some women believed that participation in PA would lead to an increase in falls or muscular strain, or being concerned for the health of baby Sleep and rest rated significantly higher in importance than PA during pregnancy and having an active lifestyle	Improving the quantity and quality of information related to PA has the potential to correct inaccurate perceptions and confer several benefits on maternal and fetal health Most commonly cited barrier to sports/exercise was maternal physical health status Small number of women reported a lack of facilities contributed to decrease PA as pregnancy progressed; thus, viable/safe facilities would offer encouraging environment for PA
Cramp & Bray (2009)	160 pregnant women Mean age 30.6 years 95% white 92% married	Prospective cohort study Assessments: Questionnaires administered at 18, 24, 30 and 36 weeks	Theory: Social Cognitive Theory Barrier self-efficacy and exercise self-efficacy	PA: Modifiable Activity Questionnaire	Barriers: most commonly reported barriers to PA included being too tired, lack of time, and physical limitations; frequency of limitations increased with pregnancy Barrier and exercise self-efficacy were correlated with each other and significantly predicted PA ($p<0.05$), accounted for up to 37% of the variance in PA Exercise self-efficacy predicted PA from gestational weeks 18 to 24 and weeks 30 to 36, while barrier self-efficacy predicted PA from weeks 24 to 30	Exercise and barrier self-efficacy prospectively predicted PA at each of three prediction periods Frequency of physical limitation barriers increased as pregnancy progressed while work-related barriers decreased as pregnancy progressed Barrier and exercise self-efficacy independently predicted PA at all three time points represented in the study
Downs & Hausenblas (2003)	89 pregnant women Mean age 29.96 years 89% white 89% married 49% college graduates	Prospective cohort study Assessments: Questionnaires administered in 2nd and 3rd trimester	Theory: Theory of Planned Behavior Attitudes, subjective norms, perceived behavioral control, intention	PA: self-report # days exercised a week	Intention and perceived behavioral control had the strongest correlations with exercise behavior, explained 47% of variance in exercise behavior Attitude and perceived behavioral control had the strongest correlations with intention, followed by subjective norm Attitude and subjective norm explained 33% of the variance in intention	Intention, but not perceived behavioral control significantly predicted pregnant women's second trimester exercise behavior Attitude, subjective norm, and perceived behavioral control predicted pregnant women's second trimester exercise intention; attitude strongest predictor and subjective norm the least
Duncombe et al (2009)	158 pregnant women Mean age 31.7 years 87.2% Australian-born 87.8% married	Prospective cohort study Assessments: Questionnaires administered at 16–23-weeks, 24–31-weeks and 32–38 weeks	Theory: Beliefs about exercise	PA: Questionnaire and 1 week exercise diary	Women participated in progressively less exercise at each time point Beliefs that low to moderate levels of exercise were unsafe predicted less exercise Most frequent reasons for exercising were fitness and enjoyment which decreased in late pregnancy; which may be due in part to significant increases in physical symptoms as pregnancy progressed	Safety concerns to some degree predicted amount and/or intensity of exercise but other factors such as fatigue, time, physical discomfort, etc. also played a role. Reasons for exercise during pregnancy changed suggesting that some women reassess their exercise priorities as their pregnancy progresses

Table 1-2. Prospective Studies Included in Review

Citation	Population Studied	Study Design	Theoretical Mediators	Measured Outcomes	Results	Conclusions
Goodwin et al. (2000)	65 nulliparous woman Mean age 30.3 years 84.6% Australian-born 86.2% married	Prospective longitudinal study Assessments: Questionnaires administered at 17 and 30 weeks	Theory: Attitude toward body image, body satisfaction	PA: Self-report exercise history questionnaire Other outcomes: Physical and psychiatric symptoms: General Health Questionnaire	Attitude toward body image moved in a positive direction from 17 to 30 weeks for the exercise group, whereas it moved in a negative direction for the non-exercise group over Exercise group had reduced frequency of somatic symptoms, anxiety and insomnia, and a higher level of psychological well-being No significant difference between total body cathexis scores between exercisers and non-exercisers	Exercisers did not have a more positive body image than non-exercisers Pregnant women who are frequent exercisers may feel more positive about the change in waist dimensions; evidence that baby is growing Women who maintained a consistent level of exercise during pregnancy were found to have a higher level of psychological well-being and a reduced frequency of somatic symptoms, anxiety and insomnia than women in non-exercise group
Hausenblas et al (2008)	61 pregnant women Mean age 29.03 years 88.5% white 88.5% married	Prospective cohort study Assessments: Questionnaires administered in 1st, 2nd, and 3rd trimesters	Theory: Theory of Planned Behavior Attitude, subjective norm, perceived behavioral control, intention	PA: Leisure-Time Exercise Questionnaire	Model 1: attitude and perceived behavioral control were significantly and independently associated with exercise intention and the amount of explained variance for constructs was small; no significant longitudinal effects of variables Model 2: only significant effect was exercise intention; exercise intention was the only longitudinal predictor of changes in exercise behavior	Attitude and perceived behavioral control were independently associated with exercise intention Subjective norm was not a significant predictor Only intention predicted long-term behavior Pre-pregnancy behavior did not significantly account for longitudinal changes
Hausenblas& Downs (2004)	104 pregnant women Mean age 29.98 years 87.5% White 88% married	Prospective cohort study Assessments: Questionnaires administered in 1st and 2nd trimester	Theory: Theory of Planned Behavior Attitude, subjective norm, perceived behavioral control, intention	PA: Leisure-time exercise questionnaire	Intention explained 17% of variance in exercise behavior [$F(1,82)=17.66$, $p<0.001$], perceived behavioral control explained an additional 7.9% of variance [$F(2,81)=13.94$, $p<0.001$], with only perceived behavioral control being a significant predictor ($p<0.01$) Attitude and subjective norm were significant and explained 68% of the variance in exercise intention	Perceived behavioral control was a significant predictor of exercise behavior; attitude and subjective norm were significant predictors of intention Perceived behavioral control was the most important cognitive determinant exercise in the first trimester
Hinton & Olson (2001a, Predictors)	622 pregnant women Mean age 28.8 years 95.7% white 2.1% Native American	Prospective cohort study of women Assessments: Questionnaires administered from second trimester until 2 years postpartum	Theory: Attitudes toward weight gain, feelings about motherhood, career role orientation, self-efficacy, locus of control, body image, social support	PA: Godin leisure time activity questionnaire	Exercise self-efficacy was the only psychosocial characteristic significantly associated with change in PA Predictors of change in PA overall were: exercise self-efficacy, age, BMI, and frequency of exercise prepregnancy Exercise prepregnancy was significantly associated with marital status, level of education, and income but not parity 20.4% of women reported becoming more physical active during pregnancy, 39.8% became less active	Information about age, exercise prior to pregnancy, income and education levels are useful in targeting increased interventions to women who are younger and of lower socioeconomic status Women who exercise prior to pregnancy tended to maintain or slightly increase PA levels but reported lower intensity, gentler activities Positive relationship between exercise self-efficacy and increased PA

Table 1-3. Prospective Studies Included in Review

Citation	Population Studied	Study Design	Theoretical Mediators	Measured Outcomes	Results	Conclusions
Hinton & Olson (2001b – Postpartum)	498 pregnant women Mean age 28.8 years 96% white 73% married or living with partner	Prospective observational cohort study Assessments: Questionnaires administered during 2nd and 3rd trimesters, 6 months and 12 months postpartum	Theory: Social Cognitive Theory Exercise self-efficacy, internal locus of control, body satisfaction, drive for thinness, feelings about motherhood, social support, career orientation	PA: Godin leisure time activity questionnaire Other outcomes: food intake	Social support, body satisfaction, positive feelings about motherhood, weight control self-efficacy, exercise self-efficacy, and intention to exercise were all significantly associated with exercise frequency ($p<0.10$) Exercise frequency was significantly and negatively related to years of education, being married/living with partner, but not associated to age, parity, income, or prepregnancy body mass index	Higher self-efficacy and intention to exercise were associated with more frequent exercise at 1 year postpartum Highly significant predictors of exercise frequency included feelings about motherhood, exercise self-efficacy, intention to exercise and husband's exercise frequency
Rauff & Downs (2011)	151 pregnant women Mean age 30 years 92% white 86.7% married	Prospective cohort study Assessments: Questionnaires administered in 1st, 2nd and 3rd trimester	Theory: Attitudes Body image satisfaction	PA: Leisure-Time Execise Questionnaire Other outcomes: Depression, gestational weight gain	1st trimester body image satisfaction did not significantly predict exercise behavior or gestational weight gain in the 2nd trimester ($p>0.05$) 2nd trimester body image satisfaction did not significantly predict exercise behavior or gestational weight gain in the 3rd trimester ($p>0.05$)	There was no mediation between body image satisfaction and exercise behavior Body image appears to be important for depressive symptoms in pregnancy, but not exercise behavior
Rodriguez & Lindmark (2000)	350 nulliparous pregnant Swedish women Mean age 27 years	Prospective cohort study Assessments: Questionnaires administered at weeks 10, 12, 20 and 32	Theory: Social support, attitudes about pregnancy, health awareness, perceived stress, hostility	PA: Health Behavior Scale Other outcomes: Smoking	Five factors predicted exercise at week 20: pre-pregnancy exercise, social support, hostility, perceived stress, and whether or not pregnancy was planned Exercise at week 20 together with health awareness predicted exercise at week 32 Women decreased total amount of time exercising and modified their activities by week 20	Hostility and social support important in predicting stress and health behaviors; high hostility- more exercise at mid-pregnancy Social support had a positive effect on exercise; social support lessened perceived stress A planned pregnancy led to less exercise Results imply that health awareness prompted women to behave in a healthy manner

*PA – physical activity

DISCUSSION

Despite the numerous benefits to physical activity during pregnancy including reduced excessive antenatal weight gain [1,2], improved course of delivery [3,4], reduced gestational diabetes [5], reduced preeclampsia [6], and reduced physical discomforts [7,8], as well as the current ACOG and DHHS physical activity guidelines, many pregnant women are not achieving the recommended level of moderate physical activity, and often become more sedentary throughout the course of pregnancy [14]. Inactivity during pregnancy contributes to numerous deleterious perinatal outcomes including excessive gestational weight gain and postpartum weight retention, which are both predictors of long-term obesity [19]. Clearly there is a need for a better understanding of what mediates exercise behavior change during the perinatal period to guide future implementation of effective physical activity intervention programs during pregnancy.

This review aimed to meet this need by examining prospective studies that followed women over time and identified potential psychosocial mediators to physical activity, and intervention studies to highlight effective strategies that target these mediators and increase physical activity during pregnancy. The comprehensive review revealed several significant psychosocial mediators that covered the following domains: beliefs (e.g. perceived benefits, barriers, severity and exercise and barrier specific self-efficacy), behavioral skills, social support, and behavioral intention.

Table 2 Intervention studies included in review

Citation	Population Studied	Study Design	Mediators	Measured Outcomes	Results	Conclusions
Chasan-Taber et al. (2011)	110 pregnant women, mean 11.9 weeks gestation 58 intervention, 58.6% <24 years of age, 55.6% Hispanic 52 control, 44.3% <24 years of age, 65.3% Hispanic	Intervention: 12 weeks, given motivational stage matched manual, PA* goals, pedometer, feedback on progress, motivational telephone calls Control: review of health and wellness, ACOG** book and mailed brochures, telephone calls about mailed materials Assessments: Questionnaires administered at baseline and 12 weeks	Theory: Social Cognitive Theory and Transtheoretical Model Exercise self-efficacy, behavioral and cognitive process of change, and decisional balance	PA: Pregnancy Physical Activity Questionnaire	After 12 weeks, intervention group had a smaller decrease in PA (-1.0 MET-hr/wk) compared to control (-10 MET-hr/wk, p=0.03) Intervention group showed a greater increase in sports/exercise (0.9 MET-hr/wk) compared to control (-0.01 MET-hr/wk, p=0.02) Intervention group reported improvements in behavioral processes of change (mean=0.37, SD=0.95), while control group reported a decrease (mean=-0.10, SD =0.58) Intervention group increased in cognitive process of change compared to control, but not statistically significant (p=0.14)	No significant differences in self-efficacy and decisional balance from pre to post intervention Exercise intervention group had a significantly smaller decrease in overall PA compared to the control group, and experienced an increase in sports/exercise compared to control Exercise intervention resulted in significantly increased behavioral process of change but did not result in significantly increased cognitive process of change, self-efficacy, and decisional balance Effective intervention for multiethnic population
Gaston & Prav-pavessis (2009)	208 pregnant women from Ontario, mean 23.94 weeks gestation 36 intervention, mean age 28, 77.8% white 33 attention control, mean age 26.39, 75.8% white 36 noncontact control, mean age 27.31, 77.8% white	Intervention: exercise brochure based on PMT*** constructs Control: Attention control- brochure on diet during pregnancy Noncontact control- no information given Assessments: Questionnaires administered at baseline, post-intervention, and 1 week follow up	Theory: PMT Perceived vulnerability, perceived severity, response efficacy, self-efficacy, goal intention, and implementation intention	PA: Leisure-Time Exercise Questionnaire	Participants in intervention group reported significantly higher perceived severity, goal intention, implementation intention, response and self efficacy Perceived severity, response efficacy, and self-efficacy predicted goal intention, which predicted implementation intention; implementation intention predicted exercise behavior Only participants in PMT group reported increases in follow-up exercise behavior Follow-up exercise significantly correlated with response efficacy, self-efficacy, goal intention, and implementation intention (8.9% of variance); only self-efficacy made significant/unique contribution to follow-up exercise	Supports presentation of factual information about maternal-fetal disease grounded in PMT is an effective source of exercise motivation Changing perceptions of vulnerability remains a challenge for health promoters PMT brochure failed to provide an opportunity for participants to form their own implementation intention plans, likely diluted importance PMT group was the only one to increase their exercise behavior Self-efficacy was the only construct in model to significantly predict implementation and follow-up exercise behavior
Wilkinson et al. (2010)	304 pregnant women, mean 19.7 weeks gestation 163 intervention, mean age 27.1, 45.7% married 141 control, mean age 27.2, 52.3% married	Intervention: pregnancy pocket book provided health education material, screening tools, goal setting, and self-monitoring activities Control: usual care Assessments: Questionnaires administered at baseline, 12 and 24 weeks	Theory: Social Cognitive Theory Self-efficacy	PA: self-report Other outcomes: smoking, fruit and vegetable intake: questionnaire	Median PA increased by 10 minutes in the intervention group and decreased by 10 minutes in the control group, statistical power was not sufficient to detect significant difference Intervention did not affect self-efficacy	Intervention group trended toward increased PA but not significant difference No change in self-efficacy Non-random allocation of participants in intervention vs. control

*PA-Physical activity

** ACOG- American College of Obstetricians and Gynecologists

***PMT- Protection Motivation Theory

Many studies reported an association between intrapersonal beliefs and engagement in physical activity during pregnancy. Beliefs about the safety of exercise during pregnancy were found to be predictive of exercise, such that beliefs that low to moderate levels of exercise were unsafe predicted less exercise [21,47]. These beliefs may also change throughout pregnancy suggesting that some women reassess their beliefs pertaining to safety of physical activity at various points throughout pregnancy [21]. Improving the quantity and quality of information related to physical activity in interventions has the potential to correct inaccurate perceptions and increase the likelihood of engagement in physical activity, which in return would confer several benefits on maternal and fetal health [52]. Given that women reassess their beliefs throughout pregnancy, consistent health awareness is an important variable for pregnant women in designing interventions [42] as well as addressing issues pertaining to safety concerns [21,47]. Evidence also suggests focusing on promoting a positive attitude about exercise (e.g. perceived benefits, more enjoyable) also increases the likelihood of physical activity engagement [37,45,46,48]. Conducting formative work on your select population to identify strategies that are perceived as enjoyable and beneficial prior to developing and implementing your intervention can ensure that the intervention will be well-received by your selected population.

Behavioral change is difficult and often times individuals who have the appropriate knowledge and skills to perform the behavior are still unable to do so due to competing barriers. Affecting the decisional balance by increasing perceived benefits and an individual's self-efficacy and decreasing perceived barriers toward physical activity positively influences the likelihood of engagement in physical activity. Many studies support the relationship between self-efficacy (e.g. a belief in one's on ability to perform a behavior) and engagement in physical activity [21,41,43,44]. In particular barrier self-efficacy, or the confidence that one can do the behavior even when faced with particular barriers, significantly predicted intention to exercise [32] and physical activity [43]. These results suggest future interventions should focus on barriers specific to pregnancy stages and identify ways to help individuals develop strategies for coping with specific barriers in effective ways, in order to increase the individual's confidence to engage in physical activity.

Social support is the information leading an individual to believe that he or she is cared for, esteemed, and a member of a network of mutual obligations [53]. The present review suggests that social support is a mediator of physical activity [44]. Findings from the prospective studies suggest that effective intervention strategies to increase social support should focus not only on the pregnant woman but also extend to her family, friends and exercise provider [47]. Moreover, observational learning/modeling behaviors have been effective such that findings suggest that a partner's exercise frequency predicts the mother's physical activity frequency [44]. Thus, identifying and enhancing existing social support networks may positively influence behavioral change. However, social support was not targeted as a mediator in any of the intervention studies included in this review. One intervention study conducted in pregnant women via motivational telephone calls targeted social support, but did not measure the mediators addressed in the study and was therefore excluded from this review [40]. Therefore, current evidence suggests that increasing social support is an effective way to increase physical activity during pregnancy, but this is yet to be demonstrated by intervention studies.

The majority of the studies in this review did not apply a theoretical framework a priori, however three of the prospective studies examined the Theory of Planned Behavior (TPB) for predicting exercise behavior in pregnant women. The TPB suggests that one's attitudes, subjective norms and perceived behavioral control predict intention and intention predicts behavior [26]. Attitudes pertain to a person's beliefs about what will happen if he or she performs the behavior and their judgment of whether the expected outcome is good or bad. Subjective norms are an individual's beliefs about what other people in his or her social group will think about the behavior and their motivation to conform to these perceived norms. Perceived behavioral control has two components: control beliefs and perceived power. Control beliefs are a person's beliefs about factors that will make it easy or difficult for the individual to perform the behavior whereas perceived power is the amount of power a person believes he or she has over performing the behavior. Two of these three studies applying the TPB found that attitude and perceived behavioral control had the strongest correlations with exercise intention, and intention predicted exercise behavior [37,45] with only one study finding a significant correlation between subjective norm and exercise intention [46]. Downs and Hausenblas (2003) and Hausenblas and Downs (2004) showed that intention and perceived behavioral control had the strongest correlations with exercise behavior, with 47% and 24.9% variance accounted for, respectively. Whereas Hausenblas et al. (2008) found only intention to be the only significant predictor of exercise behavior. One additional study examining the TPB did not examine exercise behavior, thus it was excluded from this review article, found that subjective benefits of exercise, ability to overcome environmental barriers, and ability to overcome personal barriers

which indicated high perceived behavioral control significantly predicted intention, accounting for 40% of the variance [32]. However, it is unclear whether any of these mediators increased physical activity as a meditational analysis was not conducted. These studies show a relatively consistent theoretical model for predicting exercise intention and physical activity behaviors in pregnant women. Since intention is often shown as a significant predictor of exercise behavior, these findings underscore the need for future intervention studies to focus on strategies to strengthen pregnant women's plans and objectives to exercise such as utilizing self-regulation skills. Many studies employed various self-regulation skills related to self-monitoring/self-observation, goal setting, positive reinforcement and ongoing progress feedback, all of which are effective in increasing self-efficacy, which in turn increases the likelihood of behavioral change. Future interventions should employ self-regulatory strategies to target behavioral change agents such as self-efficacy.

Two of the three intervention studies included in this review followed the SCT in various forms. The Social Cognitive Theory stems from Social Learning Theory and posits that an individual's knowledge can be influenced by observing others and it a continuous interactive cycle between an individual's behavior, personal factors and one's social and physical environment [26]. One study applied SCT by targeting self-efficacy [51]. One intervention study combined SCT with TTM and targeted additional mediators such as behavioral and cognitive process of change, and decisional balance [50]. Stage theories, such as the TTM often have the following assumptions 1) there a small number of stages, 2) there is a temporal sequence, 3) there are similar (not necessarily identical) barriers to individuals in the same stage and 4) there are different barriers to progress confronting people in different stages [54]. Two of the advantages of the TTM is that it allows for assessment of readiness to change as well as the ability to tailor intervention materials according to the appropriate stages which assumes that the intervention materials delivered will be more appropriately directed. Chasan-Taber et al. (2011) incorporated TTM by providing participants with a stage-matched manual with educational materials based on their current stage of change and motivational telephone counseling sessions specific to each participant's motivation, goals, and progress. Of the two studies following the SCT, Chasan-Taber et al. 2011 showed significant differences in the physical activity level and significantly increased behavioral process of change in the experimental group, but did not result in significantly increased cognitive process of change, self-efficacy, or decisional balance. However, Wilkinson et al. (2010), who delivered their intervention via interactive educational materials, failed to show statistical significance in physical activity levels and self-efficacy between their intervention and control groups. Although the current review is limited to two studies, these results suggest that interventions following the SCT that combine education with telephone counseling sessions based on the participant's stage of change, is more effective at increasing physical activity levels than educational materials alone in pregnant women.

In addition to the SCT and TTM, the protection motivation theory (PMT) was also used to examine whether information about exercise preventing maternal-fetal disease could be used as a source of exercise motivation. The PMT proposes that the intention to engage in a health behavior depends on 1) the perceived severity of the threat, 2) the perceived likelihood the threat will occur, 3) the efficacy of the recommended preventive behavior, and 4) the individual's self-efficacy to do the recommended preventive behavior [55]. Gaston and Pravpavessis (2009) found that using the PMT model led to significantly higher perceived severity, response efficacy, self-efficacy, goal intention and increased exercise behavior. Findings from the present review suggest that the SCT and TTM combined, as well as the PMT (although both limited to one study) may have utility in designing effective interventions during pregnancy.

Overall, numerous psychosocial mediators to physical activity during the perinatal period have been identified through prospective studies. Of these mediators, only beliefs such as self-efficacy, perceived vulnerability, and perceived severity as well as behavioral intention were targeted and measured in the intervention studies included in this review. This highlights a gap in the literature between identification of mediators and implementation of these mediators into intervention studies. In addition, the prospective studies included in this review were all conducted in mainly white, married women in the US, Australia, the UK, and Sweden thus limiting the generalizability of the existing studies. Two studies found on review of the literature examined a population of Latina women, but excluded from this review for not measuring physical activity [32] and for not examining theoretical mediators to physical activity [30]. Therefore, further studies examining more diverse populations are also needed.

Implications and future research

Future interventions should take into consideration the results from this review that suggest certain psychosocial domains of change agents such as beliefs (e.g. perceived benefits, barriers, severity and self-efficacy (e.g. barrier and exercise)), social support,

knowledge, and behavioral intention be addressed during the development and implementation phases. Future successful interventions should focus on increasing behavioral skills such as enhancing behavior-specific self-efficacy through self-regulatory skills (e.g. goal setting, self-monitoring, progress feedback), social and verbal persuasion, social modeling, outcome value expectancies, and outcome likelihood expectancies. In addition, prepregnancy activity level was also associated with physical activity behavior; suggesting that prepregnancy behavior exerts a strong influence on engagement of physical activity during the perinatal period [29,41,42]. Thus, suggesting future interventions should consider targeting participants during the preconceptual period to increase likelihood of perinatal physical activity.

Although numerous psychosocial mediators have been identified in prospective studies, very few intervention studies have applied and measured these mediators in order to increase physical activity during pregnancy. This poses difficulty in identifying which intervention strategies have been effective, highlighting the need for further studies. The present review suggests utility of the TPB, PMT and SCT/TTM in changing physical activity patterns among women during pregnancy. There is a definite need for more rigorous application of theoretical frameworks in future research. Ideally, applying a theoretical framework not only to the intervention design but also to the evaluation model is recommended; which in turn, would allow for testing the effectiveness of not only the theoretically-applied intervention but a meditational analysis to discern which theoretically-based mediators were most effective in producing behavioral change.

The dearth of intervention studies assessing how to effectively alter mediators to physical activity provides limited solid implications for practitioners. Albeit, the present findings suggest that educating pregnant women in regards to the benefits of physical activity, how to exercise safely, and the risks of a sedentary lifestyle may alter their perceptions and increase the likelihood of engagement in activity. In addition, encouraging women to increase social support (e.g. exercising with a spouse), identifying ways to make physical activity more enjoyable, and facilitating the use of self-regulatory activities such as goal setting and self-monitoring may increase regular participation in physical activity. More research is warranted to better understand the effectiveness of these strategies during pregnancy, and how to implement physical activity interventions at the community level for health care practitioners.

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