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RUNNING HEAD: Physical Activity, Self-Regulation, and Pregnancy

Effects of Online Self-Regulation Activities on Physical Activity among Pregnant and Early
Postpartum Women

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Abstract

Physical and psychological changes that occur during pregnancy present a unique challenge for women's physical activity. Using a theory-based prospective design, this study examines effects of pregnant women's (1) physical activity cognitions (self-efficacy, outcome expectancy, and safety beliefs) and (2) online self-regulation activities (goal-setting and self-monitoring) on subsequent changes in their physical activity intentions and behavior during pregnancy and immediately postpartum. We used data from three panel surveys administered to pregnant women enrolled in a web-based intervention to promote healthy pregnancy and postpartum weight, as well as log data on their use of self-regulatory features on the intervention website. Perceived self-efficacy and perceived safety of physical activity in pregnancy enhanced subsequent intentions to be physically active. Repeated goal-setting and monitoring of those goals helped to maintain positive intentions during pregnancy, but only repeated self-monitoring transferred positive intentions into actual behavior. Theoretically, this study offers a better understanding of the roles of self-regulation activities in the processes of goal-striving. We also discuss practical implications for encouraging physical activity among pregnant and early postpartum women.

Keywords: Physical Activity, Pregnancy, Self-Regulation, Goal-Setting and Self-Monitoring

Effects of Online Self-Regulation Activities on Physical Activity among Pregnant and Early Postpartum Women

Physical activity is a safe and effective way for healthy pregnant women to reduce the risk of pregnancy complications including gestational diabetes (Dempsey et al., 2004), preeclampsia (Sorensen et al., 2003), and preterm delivery (Evenson et al., 2002), and to improve physical stamina and mood during pregnancy (Poudevigne & O'Connor, 2006). Physical activity after pregnancy also reduces the likelihood of postpartum depression (Koltyn & Schultes, 1997) and weight retention (O'Toole, Sawichi, & Artal, 2003). Pregnant women are advised to engage in moderate-intensity¹ physical activity for at least 30 minutes on most, if not all, days of the week throughout their pregnancy (American College of Obstetricians and Gynecologists [ACOG], 2002). The ACOG recommends gradual return to physical activity in the immediate postpartum period, as the physiological and morphological changes of pregnancy persist 4-6 weeks after delivery.

Despite the established benefits and guidelines for physical activity during and after pregnancy, pregnant women are less likely than non-pregnant women to be physically active. Only 3-15% of pregnant women meet the current guidelines of 30 minutes per day, compared to 24-26% for non-pregnant women (Hausenblas et al., 2011; Borodulin et al., 2008; Evenson, Savitz, & Huston, 2004). Physical activity typically declines throughout pregnancy (Downs, LeMasurier, & DiNallo, 2009; Clarke et al., 2005), with only partial return of activities during the postpartum period (Pereira et al., 2007). The largest change occurs in the last trimester, often involving the replacement of strenuous activities with lighter ones (Borodulin et al., 2008; Poudevigne & O'Connor, 2006). However, there is no clear understanding of underlying psychological reasons why physical activity declines throughout pregnancy and fails to resume in the early postpartum period (Gaston & Cramp, 2011; Pereira et al., 2007).

Theory-informed interventions could enhance our understanding of ways to encourage physical activity among pregnant and early postpartum women.

Many pregnancy interventions are multidimensional and often geared toward medical or obstetric outcomes rather than physical activity (Currie et al., 2013). This makes it hard for researchers to determine the utility of the specific behavior change techniques employed to promote physical activity among pregnant women. A review of 14 randomized control trials to promote physical activity in pregnancy identified individualized goal-setting and planning with feedback (i.e., self-regulatory techniques) as the most effective intervention approaches (Currie et al., 2013). Regular face-to-face meetings were typically employed in successful interventions; none involved web-based tools for setting and monitoring individualized physical activity goals. Compared to in-person approaches, web-based self-regulatory interventions, often designed to address information deficiencies and self-management skills, have shown to improve weight loss maintenance and exercise time within the general population (e.g., Wantland et al., 2004). With improved ease and convenience of access to individualized feedback and the ability to track and monitor one's own performance (Krukowski, 2013), interventions involving online self-regulatory features have the potential to promote physical activity among pregnant and early postpartum women.

To design effective intervention programs, it is fundamental to identify key determinants of behavior and to explain how those factors predict their subsequent intentions and behaviors (Michie et al., 2008). To this end, we have two primary goals: (1) assess the effects of pregnant women's physical activity cognitions on changes in their intentions and behaviors, and (2) determine whether self-regulation features in an intervention website can encourage physical activity during and early after pregnancy.

Self-Regulation as a Theoretical Framework

Self-regulation broadly refers to the processes of goal-setting and goal-striving, which involves dealing with challenges that one faces in achieving one's goals (Mischel, Cantor, & Feldman, 1996; Carver, 2004). Most models of self-regulation are based on classic social-cognitive theories (e.g., Bandura, 1997; Theory of Planned Behavior, TPB, Ajzen, 1991). However, unlike most social-cognitive models that view behaviors as static events, self-regulation approaches consider behaviors in the context of the long-term goals, emphasizing the importance of behavioral maintenance to achieve those goals (de Ridder & de Wit, 2006; Abraham & Sheeran, 2000). Research suggests that behavioral maintenance occurs in two phases: (1) a motivational phase where people decide to act, and (2) a volitional phase where people plan to perform the behavior (Gollwitzer, 1993; Heckhausen & Gollwitzer, 1987).

The motivational phase parallels the view of classic social-cognitive models, which propose a set of beliefs as proximal determinants of motivation, in many cases represented as a behavioral or goal intention (Ajzen, 1991; Gollwitzer, 1993). According to Bandura (1977), individuals create expectations of future outcomes by weighing the costs and benefits of performing a behavior. For instance, perceived benefits of physical activity in pregnancy (e.g., make oneself more energetic or improve one's delivery; Cioffi et al., 2010) are likely to enhance pregnant women's intentions, whereas perceived costs (e.g., safety issues associated with physical activity in pregnancy; Hausenblas et al., 2011) are likely to discourage pregnant women from being physically active. Intentions and behavior are further governed by an individual's self-efficacy, which refers to perceived capability to perform a behavior (Bandura, 1991). Pregnant women are more likely to form positive intentions and act on them when they perceive themselves as more capable of performing physical activity. To our knowledge, while a few qualitative studies document pregnant women's physical activity cognitions (Cioffi et al., 2010; Hausenblas et al., 2011), studies have yet to examine the causal effects of those cognitions on subsequent intentions and behaviors. Declines in

physical activity during pregnancy could be linked to pregnancy-specific beliefs and concerns that may change over the course of pregnancy. We thus examine how cognitions during pregnancy contribute to the motivational phase in deciding whether to engage in physical activity in pregnancy and early postpartum.

Hypothesis 1 (H1): Higher (a) self-efficacy, (b) positive outcome expectancy, and (c) perceived safety of engaging in physical activity at baseline will increase subsequent intentions to be physically active in later stages of pregnancy and early postpartum.

Social-cognitive models theorize behavioral intention as the strongest and most proximal predictor of behavior (Ajzen, 1991). Self-regulation researchers, however, argue that intentions do not always translate into behaviors, conceptualizing intentions as only the starting point for behavioral performance (Gollwitzer, 1993; Heckhausen, 1991). These models argue that it is in the volitional phase where individuals develop strategies and plans to ensure their behavioral enactment (Milne, Orbell, & Sheeran, 2002; Gollwitzer, 1993). Implementation intention² (specifying when, how, and where an intended behavior will be enacted; action planning) is one volitional strategy that is effective at reducing the intention-behavior gap (Gollwitzer, 1993). In a recent study (Gaston & Prapavessis, 2014), augmenting motivational interventions with action planning enhanced exercise behavior change among pregnant women. We examine two other volitional strategies, goal-setting and self-monitoring, that have received relatively limited empirical inquiry despite their frequent employment in many behavioral intervention programs.

Self-regulation theorists contend that goals differ in abstraction and can be organized hierarchically, in which lower goals are controlled by higher order goals (Carver & Scheier, 1998). As such, we conceptualize goal-setting as a volitional strategy that involves itemizing and ordering goals to achieve one's specified higher order goal to be physically active. People often get side-tracked by competing (immediate) goals that interfere with striving for

their long-term, higher order goals (de Ridder & de Wit, 2006). Itemized action goals with specific timelines could help individuals to be on track by reducing the ambiguity about what is to be attained (Locke & Latham, 2002). People also need feedback on their own performance levels in order to adjust the level or direction of their goal-directed effort (Locke & Latham, 2002). Thus self-monitoring, defined as systematic observation and reporting of one's progress toward specified goals, could serve as a supplementary strategy for goal-striving. The combination of goal-setting and feedback is thought to be more effective than goal-setting alone (Bandura & Cervone, 1983).

Based on the TPB (Ajzen, 1991), we posit that higher intentions at baseline, as a function of positive expectancy and efficacy beliefs (as proposed in H1), will be associated with greater physical activity in later stages of pregnancy and early postpartum. Self-regulatory activities are also likely to help pregnant women maintain positive physical activity intentions and to enhance their actual behavior (Gaston & Prapavessis, 2014). Studies show that repeated engagement in self-regulatory activities is more effective at achieving weight control outcomes than engaging in these activities a single time or not at all (Krukowski et al., 2013). Thus, we predict:

Hypothesis 2 (H2): Higher intentions at baseline will be associated with increased physical activity in later stages of pregnancy and early postpartum.

Hypothesis 3 (H3): Repeated online (a) goal-setting and (b) self-monitoring during pregnancy will be associated with increased physical activity intentions and behavior in later stages of pregnancy and early postpartum.

Volitional strategies can be useful for reducing the intention-behavior gap (Gollwitzer, 1993). Researchers posit that intention formation must precede the volitional phase because self-regulatory strategies function in the service of goal intention (Gollwitzer, 1993; Milne et al., 2002). Once an intention is formed, people consciously and purposefully set goals as

guiding principles for their behavioral enactment (Austin & Vancouver, 1996; de Ridder & de Wit, 2006). Thus, higher physical activity intentions at baseline are likely to promote online goal-setting and self-monitoring, which may in turn increase subsequent intentions and behavior. Specifically, we predict:

Hypothesis 4 (H4): Repeated online (a) goal-setting and (b) self-monitoring during pregnancy will mediate the effect of physical activity intentions at baseline onto later intentions and physical activity in later stages of pregnancy and early postpartum.

In sum, we examine effects of pregnant women's physical activity cognitions (H1: expectancy and efficacy beliefs; H2: prior intentions) on changes in their intentions and behaviors. We also test whether self-regulation features in an intervention website can encourage physical activity during and early after pregnancy, both directly (H3) and indirectly mediating the influence of prior intentions (H4).

Methods

We used data from three surveys administered to a panel of women enrolled in a web-based intervention designed to promote healthy pregnancy and postpartum weight. We also linked records of participants' use of self-regulatory features in the intervention website to the survey data to determine the impact of their use on later physical activity.

Web-Based Intervention

Participants. Pregnant women aged between 18 and 35 were invited to a randomized trial through four participating hospitals in the Northeast U.S. To be eligible, participants had to (1) consent at or before 20 weeks gestation, (2) be available for a 24 month intervention, (3) plan to carry their pregnancy to term and keep their baby, (4) read and understand English, and (5) have a valid email address. Exclusion criteria included: body mass index (BMI) < 18.5 kg/m² (underweight) or \geq 35.0 kg/m² (class-II obese), multiple gestation (e.g., twins), having had eating disorders or gastric bypass surgery in the past, having had three or more

consecutive miscarriages, and the presence of pre-pregnancy medical conditions that could influence weight loss or gain. All intervention materials, study procedures, and research instruments were approved by the Institutional Review Boards of the PI's home institutions and the participating hospitals.

Intervention features. Eligible participants ($N = 1,664$) were randomized to one of 3 conditions: (1) a healthy weight intervention during pregnancy and postpartum ($n = 554$), (2) a healthy weight intervention during pregnancy only ($n = 556$), and (3) a non weight-based control ($n = 554$). Pregnant women in all conditions received a variety of pregnancy-related information and features, including informational and interactive features that they could use to gather information and advice about pregnancy, maintain calendars for their appointments with their care provider, and share experiences with other participants through blogs. The intervention (conditions 1 & 2 for the prenatal period; 1 for the postpartum) provided participants with access to additional website features to support healthy weight during and after pregnancy: (1) entering their weight regularly into a weight gain tracker, and (2) goal-setting and self-monitoring tools in the areas of diet or physical activity. For the current analysis, we focused on the use of tools related to physical activity to determine their impact on physical activity during pregnancy and early postpartum. Effects of randomized treatment on weight outcomes will be presented in future papers.

The physical activity intervention employed several behavior change techniques such as (1) specific goal-setting, coping planning (barrier identification), and contingent rewards, and (2) self-monitoring of specified goals (Michie et al., 2013; Abraham & Michie, 2008). To use the physical activity features on the Web, participants first reviewed information on physical activity in pregnancy (the National Institute of Diabetes and Digestive and Kidney Diseases [NIDDK] recommendations) and reported whether or not they could be physically active during pregnancy based on their care provider's advice (e.g., contraindications for

physical activity). If a participant had contraindications, she was advised to avoid physical activity during pregnancy. Those without contraindications further assessed whether she was sedentary prior to current pregnancy and reported the types of activity she is currently engaged in. Based on these computerized assessments, the intervention website named appropriate goal areas (i.e., activities that a participant should consider) and the total amount of activity. If a woman was sedentary, for instance, the website recommended moderate level intensity activities such as walking, swimming, cycling, and aerobics for 90 to 120 minutes per week.

Women were then prompted to set personal goals by specifying types of activities they hoped to participate in and specify a timeline to accomplish these goals (goal-setting for behavior). The website also outlined barriers that could be encountered in the pursuit of these goals, and described strategies to overcome those barriers. Participants then selected which strategies they will employ to overcome barriers for each goal (coping planning) and what type of rewards they would like to receive once they achieve their specified goals (contingent rewards). Prompting goal-setting, coping planning, and contingent rewards occurred in one sequence of online engagement; thus, we cluster these activities and refer to 'online goal-setting'. Participants were also given opportunities to review and monitor goals that they had set (self-monitoring of behavior). Women could return to the website to monitor progress or remind themselves of their physical activity goals.

Survey Administration

All eligible participants ($N = 1,664$) were asked to complete questionnaires at two time points during pregnancy and one time point early postpartum. The first survey (T1) was administered between program enrolment and 28 weeks into each participant's pregnancy (i.e., the first and second trimesters). The second survey (T2) was administered from 32 weeks into each participant's pregnancy until her delivery at 40 weeks. The last survey (T3)

was administered between 6 and 12 weeks after delivery. Among the eligible participants, 84 percent ($n = 1,400$) completed some part of the questionnaire at T1, 57 percent ($n = 952$) at T2, and 48 percent at T3 ($n = 794$). Among those who completed some portion of the three surveys ($n = 1,428$), we excluded those (1) who were advised to be sedentary by their primary caregiver at any point in their pregnancy (T1, $n = 63$, 4.5% of $n = 1,400$; T2, $n = 82$, 8.6% of $n = 952$), and (2) who dropped out from the intervention program before delivery and those who miscarried, lost, or delivered a baby before 28 weeks gestation ($n = 160$). We also excluded those who did not answer any of the questions relevant to the current study ($n = 27$), resulting in a total analytic sample of $n = 1,116$.

Measures

Self-efficacy. Participants reported at T1 how sure that they will be able to complete 30 minutes of moderate-intensity physical activity on 5 or more days per week during pregnancy (Cramp & Bray, 2009; 1 = very unsure, 5 = very sure). On the same scale, we also assessed women's perceived efficacy to be physically active under 5 specific occasions during pregnancy: "when [you are tired; you are in a bad mood; you don't feel you have the time; you are on vacation; it is raining or snowing]" (Marcus, Selby, Niaura, & Rossi, 1992; Kim et al., 2008; Chasan-Taber et al., 2009). We averaged these responses into an index of self-efficacy (6 item $\alpha_{T1} = .84$; $M = 3.07$, $SD = .96$).

Outcome expectancy. At T1 and T2, we assessed both positive and negative outcome expectancies relevant to physical activity in pregnancy. Three items were averaged to measure positive expectancy (Evenson & Bradley, 2010; 1 = strongly disagree, 5 = strongly agree): "Pregnant women will gain some benefit from moderate-intensity physical activity", "Physical activity and exercise during pregnancy [can make a woman feel more energetic; will improve a woman's labor and delivery]" (3 item $\alpha_{T1} = .82$, $M = 4.29$, $SD = .61$; $\alpha_{T2} = .79$, $M = 4.19$, $SD = .58$). As a measure of negative expectancy, participants reported perceived

safety of two items, averaged into a single scale (Mudd, Nechuta, Pivarnik, & Paneth, 2009): safety of (1) moderate intensity and (2) vigorous physical activity in pregnancy (1 = very unsafe, 5 = very safe; 2 items $r_{T1} = .30$, $M = 3.39$, $SD = .77$; $r_{T2} = .36$, $M = 3.28$, $SD = .80$, both $r, p < .001$).

Intentions and physical activity. At T1 and T2, participants reported on “How likely is it that you will engage in 30 minutes of moderate-intensity physical activity on 5 or more days per week for the rest of this pregnancy?” (Mudd et al., 2009; 1 = very unlikely, 7 = very likely; $M_{T1} = 4.77$, $SD = 1.93$; $M_{T2} = 4.13$, $SD = 2.17$). At T1, T2, and T3, participants reported their frequency of moderate-intensity physical activity (1 = never, 2 = hardly ever, 3 = rarely, 4 = sometimes, 5 = often), “At this time in your pregnancy [currently], how often do you do physical activity which makes your heart and breathing rate moderately increase?” ($M_{T1} = 3.32$, $SD = 1.07$; $M_{T2} = 3.66$, $SD = 1.04$; $M_{T3} = 3.18$, $SD = 1.15$). On the same scale at T1, participants reported their level of pre-pregnancy physical activity ($M = 3.73$, $SD = .96$).

At T1 and T2, using the Pregnancy Physical Activity Questionnaire (PPAQ; Chasan-Taber et al., 2004), we additionally assessed the amount of time spent on leisurely, moderate-intensity, activities such as walking quickly, swimming, jogging, and taking prenatal exercise classes. To calculate total leisurely physical activity (MET-hrs/week)³, we summed the duration of these activities and multiplied by its intensity based on the Compendium of Physical Activities (Ainsworth et al., 2000; $M_{T1} = 7.11$, $SD = 9.12$, $Mdn = 4.75$; $M_{T2} = 5.95$, $SD = 7.66$, $Mdn = 3.00$). To keep the measurement consistent across at T1, T2, and T3, we primarily used the frequency measure of physical activity in hypothesis testing. Yet, we repeated the same analyses with total MET-hrs/week as a comparison when examining the prospective relationships between T1 and T2.

Online goal-setting and self-monitoring. We monitored participant’s online self-regulatory activities throughout their prenatal and early postpartum period. Each online entry

was time-stamped to record the frequency and timing. Based on these records, we grouped women into three categories depending on their level of participation, separately for goal-setting and self-monitoring features: those who had (1) no entry, (2) only one entry, and (3) repeated entries (defined as having two or more records; Verheijden, Jans, Hildebrandt, & Hopman-Rock, 2007). During the prenatal period, out of $N = 750$ who received intervention, 37% engaged in goal-setting (*range* = 1-11, 13% repeated entry) and 31% self-monitored those goals (*range* = 1-87, 24% repeated entry). During early postpartum, out of $N = 370$ in the intervention group, only 3% engaged in goal-setting (*range* = 1-4, .5% repeated entry) and 2% self-monitored those goals (*range* = 1-26, 1.1% repeated entry).

Analytic Approach

Using repeated-measures analyses of variance (ANOVAs), we first examined (1) patterns of change in physical activity at T1, T2, and T3, and (2) whether the observed pattern, if any, differs between intervention conditions or demographic groups that had been associated with higher physical activity in pregnancy. We used generalized linear models (GLM) to examine our primary hypotheses about the prospective relationships between study constructs: (1) *H1*: T1 cognitions \rightarrow T2 intention, controlling for T1 intention; (2) *H2*: T1 intention \rightarrow T2 physical activity, controlling for T1 physical activity; T2 intention \rightarrow T3 physical activity, controlling for T2 physical activity; (3) *H3*: online self-regulatory activities \rightarrow T2 intention and physical activity, controlling for T1 intention and physical activity. The TPB (Ajzen, 1991) predicts that intentions mediate the effects of expectancy and efficacy beliefs on behaviors. We thus ran two separate models, with and without intentions, in testing *H2*. We tested the mediation hypothesis (*H4*) with the PROCESS macro to estimate path coefficients and bootstrap bias corrected confidence intervals (CI; 5,000 samples; Preacher & Hayes, 2008). Only significant relationships from *H3* were subject to mediation analyses. In each mediation model, we controlled for significant cognitive predictors from *H1* and *H2*.

Because online self-regulatory features were available only to the intervention group, we excluded those who were assigned to the control in testing H3 and H4. Each model controlled for the intervention conditions and demographic predictors.

Results

Participant Profile

At baseline (T1), majority of participants were White (70%) and 36% were from low income household (at less than 185% of poverty line). About half of respondents (51%) had received a college or higher degree and 26% had completed some college/technical school. More than half of respondents had normal pre-pregnancy BMI (57%) and did not have other children at home (57%). Participant demographics did not statistically differ between intervention conditions (all $ps > .05$). Longitudinal data for T1 and T2 were available for 68% ($n = 761$) of the 1,116 participants, whereas data for T2 and T3 and T1 and T3 were available for 52% ($n = 584$) and 62% ($n = 687$), respectively. Parental status and pre-pregnancy BMI did not statistically differ between participants at T1, T2, and T3. However, we observed higher dropout rates among non-White, low income participants, and those who received less formal education. We accounted for these differences by controlling for these factors in subsequent analyses. Table 1 summarizes respondent demographics.

Patterns of Change in Physical Activity

A repeated-measures ANOVA revealed a significant curvilinear relationship between three physical activity behavior measures reported at different time points, $F = 88.80$, $p < .001$. Planned pairwise comparisons showed a significant increase in the frequency of physical activity from T1 ($M = 3.30$) to T2 ($M = 3.66$), followed by a significant decrease at T3 ($M = 3.20$), both comparisons $p < .001$ (between T1 and T3, $p = .09$). This pattern was more prominent among non-White participants (Time*White, $F = 5.12$, $p = .02$), perhaps due to their lower physical activity level at T1 ($M = 3.17$; $M_{white} = 3.33$) and T3 ($M = 2.89$; M

white = 3.28) compared to White (no difference at T2). There was no significant main effect of the intervention condition, nor did any other demographic factors interact with the intervention condition to predict the pattern of physical activity change. Total leisurely physical activity (MET-hrs/week) significantly correlated with the frequency of moderate-intensity physical activity ($r_{T1} = .39$, $r_{T2} = .35$, both $p < .001$). Yet, total leisurely physical activity significantly declined from T1 to T2 ($M_{T1} = 6.82$, $SD = 8.74$; $M_{T2} = 6.07$, $SD = 7.77$), $t(717) = 2.22$, $p = .03$, contrary to the pattern found with the frequency of physical activity.

Factors that Promote Physical Activity during Pregnancy and Early Postpartum

Physical activity cognitions. Paired samples t-tests showed general declines in the levels of positive outcome expectancy ($M_{T1} = 4.34$, $M_{T2} = 4.19$), perceived safety ($M_{T1} = 3.40$, $M_{T2} = 3.28$), and intentions ($M_{T1} = 4.71$, $M_{T2} = 4.12$) from T1 to T2, all comparisons $p < .001$. As presented in Table 2, controlling for T1 intentions, higher self-efficacy (H1a, $B = .42$, $p < .001$) and perceived safety at T1 (H1c, $B = .28$, $p = .004$) significantly enhanced intentions at T2, but not the positive expectancy (H1b, $p = .39$). Controlling for prior physical activity, only self-efficacy was a significant predictor of T2 physical activity ($B = .13$, $p = .001$), which became non-significant after the inclusion of intention. Higher intentions enhanced subsequent physical activity, supporting H2⁴ ($B_{T2} = .07$, $B_{T3} = .08$, both $p < .01$). The influence of intentions on subsequent physical activity did not differ between intervention conditions. Although not hypothesized, self-efficacy remained a significant predictor of T3 physical activity alongside intentions, $B = .17$, $p = .001$. Contrary to the positive effect on T1 intentions, perceived safety at T2 reduced physical activity after delivery ($B = -.15$, $p < .05$), controlling for T2 physical activity.

Online goal-setting and self-monitoring. To ensure prospective relationships between variables in testing H3, we included online activities that occurred before each participant's survey initiation at T2 and T3 (see Table 3). Compared to those who did not self-monitor,

repeated self-monitoring during early pregnancy significantly increased subsequent intentions ($B = .79, p < .001$) and physical activity ($B = .21, p < .05$) at T2, controlling for T1 (H3b). Goal-setting at least once increased T2 intentions ($B = .50, p < .01$) and physical activity ($B = .20, p < .05$, versus no goal-setting) controlling for T1 intentions and activity, but repeated goal-setting was more predictive of intentions than setting a single goal ($B = .73, p < .01$; H3a). Early postpartum goal-setting did not predict physical activity at T3. Repeated self-monitoring during early postpartum increased physical activity at T3 ($B = 1.00, p < .05$; H3b). Neither goal-setting nor self-monitoring during pregnancy predicted physical activity after delivery. Thus, H3b was supported but H3a was only partially supported (only T2 intentions).

Mediation Models

Controlling for self-efficacy, perceived safety, and physical activity at T1, intentions at T1 significantly increased subsequent goal-setting ($b = .08, p < .001$) and self-monitoring ($b = .08, p = .006$) that occurred between T1 and T2, which in turn significantly increased intentions at T2 (the indirect effect via goal-setting, 95% CI = .01 to .06; via self-monitoring, 95% CI = .01 to .06). Controlling for T1 physical activity, intentions at T1 also indirectly transferred into physical activity at T2 through self-monitoring (indirect 95% CI = .001 to .02), but not via goal-setting (indirect 95% CI = -.001 to .01). We thus conclude that both types of self-regulatory activities mediate the effect of baseline intentions onto later intentions, but only self-monitoring mediates positive intentions onto actual physical activity.

Discussion

This prospective study examined effects of pregnant women's physical activity cognitions on subsequent changes in their intentions and behavior. Guided by the self-regulation approach, we assessed the utility of online self-regulation tools in promoting physical activity during and early after pregnancy.

Physical Activity in Pregnancy and Early Postpartum

Despite the established benefits and guidelines for physical activity in pregnancy, physical activity level typically declines throughout pregnancy (Downs et al., 2009; Clarke et al., 2007). In the present study, pregnant women's frequency of physical activity increased from T1 to T2, but this pattern was not associated with the intervention conditions or demographics. One possible explanation is that participants reported T1 frequency of physical activity in reference to the immediate preceding question about their physical activity prior to pregnancy. Because most women assume declines in the frequency physical activity during pregnancy compared to their pre-pregnancy stage, participants might have reported T1 levels lower ($M = 3.30$) than their actual levels because they implicitly used pre-pregnancy scores as a reference ($M = 3.73$). Alternatively, the unexpected finding may be attributed to the fact that the frequency measure did not account for the duration of physical activity. Indeed, the amount of time pregnant women engaged in leisurely activities such as walking and jogging decreased from T1 to T2, consistent with prior research findings (Downs et al., 2009; Clarke et al., 2005).

Researchers have documented physical activity cognitions specific to pregnant women, such as fear of miscarriage and difficulty due to nausea or increased weight and size, that likely discourage their active participation in physical activity (Hausenblas et al., 2011). In the present study, perceived safety of physical activity in pregnancy helped pregnant women maintain their positive intentions to be physically active. However, positive expectancies of physical activity were not significant motivators for pregnant women to maintain their intentions. Although both perceived safety and positive expectancies declined from T1 to T2, reducing the decline in perceived safety appears to be more important for maintaining positive intentions among pregnant women.

Perceived efficacy emerged as the strongest predictor of intentions and physical activity both during and after pregnancy. The inclusion of intention made the effect of self-

efficacy insignificant on physical activity during pregnancy, whereas it remained significant alongside intention early after delivery, indicating a partial mediation. The latter may be due to women's (perceived) limited control over physical activity resumption after delivery because of medical complications, persisting physiological changes of pregnancy, as well as lack of assistance with childcare and sufficient time (Artal & O'Toole, 2003; Scott, 2006; Smith et al., 2005). Declines in physical activity during pregnancy tend to persist at 6-month postpartum (Pereira et al., 2007). In the present study, women's physical activity further declined during immediate postpartum compared to their last pregnancy trimester. Given that women without any complications can resume physical activity soon after delivery (Scott, 2006), care providers should inform healthy women about the safety and efficacy of physical activity resumption early after delivery. In doing so, efforts should be accompanied to reduce the environmental barriers, for instance, by offering childcare support while women are engaging in physical activity.

The Utility of Online Goal-Setting and Self-Monitoring

As predicted by the TPB (Ajzen, 1991), intention was a constant, significant predictor of subsequent physical activity during and after pregnancy. In light of the self-regulation approach, we hypothesized that engagement in online self-regulatory activities would also promote subsequent physical activity. Pregnant women who repeatedly self-monitored their physical activity goals through an online feature were more likely to be physically active at later pregnancy stage than those who did not engage with the feature. Beyond physical activity, our finding also suggests that repeated self-monitoring can help maintain pregnant women's positive intentions, enabling them to strive for their long-term physical activity goals. Unlike self-monitoring, which required repeated participation to make a positive impact, goal-setting at least once was able to maintain positive intentions with repeated engagement strengthening the relationship. Repeated goal-setting, however, did not improve

subsequent physical activity, suggesting that the role of goal-setting could be limited to maintaining motivations (intentions) rather than the behavioral enactment.

Behavior is most likely when an individual is both motivated to act and has developed volitional strategies that promote behavioral enactment (de Ridder & de Wit, 2006). Consistent with the theoretical claim that goal intentions precede the volitional phase (Gollwitzer, 1993), pregnant women with higher intentions were more likely to set physical activity goals and self-monitor their progress, both of which, in turn, helped to maintain these positive intentions. Repeated self-monitoring also transferred the effect of intentions into subsequent behavior. Scholars suggest that goal-striving relates to individual's satisfaction with perceived progress towards their goals (Carver & Scheier, 1998). As people often lack awareness of their own performance levels for goal pursuit, repeated self-monitoring could be a way to incentivize oneself to achieve his/her specified goals by continuously being informed of own progress. Future research should further investigate the mechanisms through which self-monitoring could help reduce the intention-behavior gap.

Strengths and Limitations

It is important to develop pregnancy-specific interventions taking into account the physical and psychological changes that occur over the course of pregnancy. There is, however, a lack of research that examines the effects of pregnancy-specific cognitions on women's physical activity during and following pregnancy. This study advances the extant literature by using a theory-based prospective design, following pregnant women's physical activity cognitions as well as their self-regulatory activities, to identify factors that help promote their physical activity. Perceived safety enhanced physical activity intentions during pregnancy, whereas it negatively influenced physical activity after delivery. Future research should further examine the role of perceived safety and other important pregnancy-specific cognitions, which may vary by trimester or between prenatal and postpartum periods.

Pregnant women were randomly assigned to intervention conditions, but we found no intervention effect on their physical activity. This is likely because our intervention was designed to promote a combination of lifestyle factors relevant to healthy pregnancy and postpartum weight, not just physical activity. We did observe a significant impact of the specific behavior change techniques employed to promote physical activity, among those women who utilized them as intended. Online self-regulatory activity, particularly self-monitoring, had a positive impact on subsequent physical activity, suggesting its practical utility in intervention programs targeting pregnant women.

Several study limitations are worth noting. First, the statistical power was weak in relation to the effects of self-regulatory activities on subsequent physical activity, largely owing to the fact that a majority of women did not utilize these features. Future work with a larger proportion of participants who engaged in self-regulatory activities may offer stronger evidence for the findings reported here. Second, given higher dropout rates among certain demographic groups, there is the potential for selection bias. Study results, particularly the comparisons between different measurement points, should be cautiously interpreted when applied to the population of pregnant women. Third, a single, self-report measure to assess physical activity is susceptible to measurement errors. Although we supplemented our frequency measure with a validated multi-measure scale, the PPAQ, this measure was used only during pregnancy. Future work could further benefit from the use of multi-measure scale or objective measures (e.g., accelerometer; Gaston & Prapavessis, 2014) of physical activity both during and after pregnancy. Lastly, some of our belief measures (e.g., outcome expectancies) do not directly correspond to the behavioral target in terms of duration and frequency of physical activity. A closer correspondence between measures may have strengthened the effects of these theoretical constructs in predicting physical activity intentions and behaviors.

Conclusions

Pregnancy presents a unique challenge for women's physical activity. Motivational interventions that provide safety and efficacy information may help reduce declines in physical activity intentions that typically occur during the course of pregnancy. Once positive intention is formed, offering pregnant women with opportunities to exercise self-regulatory activities, particularly self-monitoring, through an online feature is likely to promote their actual behavioral performance.

Endnotes

1. Defined as activity with an energy requirement of 3-6 metabolic equivalents (METS), which equals to brisk walking at 3-4 mph for healthy adults (Chasan-Taber et al., 2014).
2. Implementation intentions differ from how we employed goal-setting in our intervention program. Implementation intention is typically created at once in the form of an “if-then plan”, whereas our goal-setting tool involved selection of action plans followed by entering number of weeks to complete each selected action plan. This goal-setting sequence could be performed repeatedly if participants wished to.
3. Women with above 7.5 MET-hrs/week in leisurely moderate-intensity activities are considered to have met the ACOG guideline (30 minutes/day*3>METs*5 days/week; Chasan-Taber et al., 2014; ACOG, 2002).
4. A parallel regression analysis revealed an insufficient direct effect of T1 intentions on total MET-hrs/week at T2 (rejecting H2). However, T1 intentions indirectly increased total leisurely activity through repeated self-monitoring (supporting H4; indirect 95% CI = .007 to .13). All other regression results were consistent with those based on the frequency measure of moderate-intensity physical activity.

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Table 1. Participant Demographics and Physical Activity

	<i>Time 1</i> <i>N = 1,077</i>	<i>Time 2</i> <i>N = 792</i>	<i>Time 3</i> <i>N = 702</i>
Pre-pregnant Body Mass Index (BMI)			
Normal	57	58	59
Overweight and Class I Obese	43	42	41
Race			
White or Caucasian	70	73	79
Black or African American	17	14	9
Other	13	13	12
Income			
High	64	68	73
Low	36	32	27
Highest Level of Education Completed			
High School Diploma or Less	23	19	14
Some College or Technical School	26	24	24
College Degree or Higher	51	57	62
Children at Home			
Have other children	43	44	45
No other children (first pregnancy)	57	56	55
Frequency of Physical Activity			
Often (everyday)	12	21	11
Sometimes (every other day)	36	44	32
Rarely (once a week)	28	20	28
Hardly ever	18	12	19
Never	06	03	09
Total Leisurely Activity (MET-hrs/week)			
Below the ACOG guideline	64	70	-
Met the ACOG guideline (> 7.5 METs)	36	30	-

Notes. Percentage. *N* = those who reported their physical activity level at each measurement; BMI based on participant's pre-pregnancy body weight and height reported at the recruitment. Overweight = $25.0 < \text{BMI} < 30$ and class I obese = $30 \leq \text{BMI} < 35$; Low Income = those who receiving or eligible to receive PCAP (expanded Medicaid for during pregnancy which is for those at less than 185% of poverty line) in the past 12 months.

Table 2. The Effects of Pregnancy Cognitions on Intentions and Physical Activity (N = 1,116)

	<i>T2</i>	<i>T2</i>		<i>T3</i>	
	<i>Intentions</i>	<i>Physical Activity</i>		<i>Physical Activity</i>	
Low income	.34	.02	.02	.03	.01
White	-.11	-.04	-.06	.44***	.46***
Have other children	-.34*	-.02	.001	.15	.19*
College degree or higher	-.20	.05	.04	-.02	.03
Prenatal intervention	.02	.02	.01	.02	.03
Postpartum intervention	-	-	-	.003	-.03
Self-efficacy	.42***	.13***	.07	.22***	.17***
Positive outcome expectancy	-.11	-.05	-.07	.10	.08
Perceived safety	.28**	.03	.02	-.12*	-.15*
Intentions	.36***	-	.07**	-	.08**
Physical activity	-	.31***	.28***	.30***	.22***

Note. Unstandardized coefficients. * $p < .05$, ** $p < .01$, *** $p < .001$. Control condition served as a reference to the prenatal and postpartum intervention conditions. Physical activity = frequency of moderate-intensity activities.

Table 3. The Effects of Online Self-Regulatory Activities on Intentions and Physical Activity

	<i>T2</i>		<i>T2</i>		<i>T3</i>	
	<i>Intentions</i>		<i>Physical Activity</i>		<i>Physical Activity</i>	
Low income	.53*	.49*	.11	.10	.08	-.002
White	-.05	-.11	-.02	-.03	.28	.26
Have other children	-.04	-.04	.11	.10	.13	.09
College degree or higher	-.02	-.08	.15	.14	-.05	-.13
Self-efficacy	.36***	.33**	.05	.04	.34***	.33***
Positive outcome expectancy	-.07	-.07	-.09	-.09	-.05	-.04
Perceived safety	.15	.15	-.02	-.01	-.11	-.11*
Intentions	.36***	.37***	.07*	.07*	.02	.01
Physical activity	-	-	.29***	.29***	.22*	.23**
Goal-setting (Ref. = none)	Ref.	-	Ref.	-	Ref.	-
Once	.50*		.20*		.42	
Repeated	.73**		.18		.69	
Self-monitoring (Ref. = none)	-	Ref.	-	Ref.	-	Ref.
Once		.30		.11		-.88
Repeated		.79***		.21*		1.00*

Note. Unstandardized coefficients. * $p < .05$, ** $p < .01$, *** $p < .001$. Models include only intervention conditions (prenatal $N = 750$; postpartum $N = 370$). Goal-setting and self-monitoring: prenatal period (enrolment until T2 survey), postpartum period (from delivery to 12 weeks postpartum). Physical activity = frequency of moderate-intensity activities.