

# Exploring the need for interventions to manage weight and stress during interconception

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**Abstract** Interventions to manage weight and stress during the interconception period (i.e., time immediately following childbirth to subsequent pregnancy) are needed to promote optimal maternal and infant health outcomes. To address this gap, we summarize the current state of knowledge, critically evaluate the research focused on weight and stress management during the interconception period, and provide future recommendations for research in this area. Evidence supports the importance of weight and stress management during the reproductive years and the impact of weight on maternal and child health outcomes. However, evidence-based treatment models that address postpartum weight loss and manage maternal stress during

the interconception period are lacking. This problem is further compounded by inconsistent definitions and measurements of stress. Recommendations for future research include interventions that address weight and stress tailored for women in the interconception period, interventions that address healthcare providers' understanding of the significance of weight and stress management during interconception, and long-term follow-up studies that focus on the public health implications of weight and stress management during interconception. Addressing obesity and stress during the interconception period via a reproductive lens will be a starting point for women and their families to live long and healthy lives.

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## Rationale

### Management of weight and stress during the interconception period are critical for maternal and child health

Interconception care is crucial to promote optimal maternal and fetal health outcomes (ACOG Committee opinion no. 549: Obesity in pregnancy, 2013; Johnson et al., 2006). The interconception period represents a window of opportunity to help women improve their health, thus reducing the risk of adverse outcomes related to excess weight or stress in subsequent pregnancies (Athukorala et al., 2010; DiPietro, 2004; O'Donnell et al., 2009; Thomas et al., 2014). The interconception period begins immediately following childbirth and ends with a subsequent conception (Currie et al., 2016; Huberty et al., 2013).

The post-partum period, typically considered the first 6–12 months following childbirth (Antheunis et al., 2013; Lagan et al., 2010) is included in the interconception period. While all parous women could be considered in the interconception period until they may or may not conceive again, we focus this review on the first 18 months following childbirth, as a third of women conceive again within this time frame (Korkeila et al., 1998; Rhoades et al., 2016; Sharma, 2014; Thomas et al., 2014).

A recent National Vital Statistics report (2015) cited median interpregnancy intervals (IPIs) ranging from 25 to 32 months, however approximately 30% of all IPIs are less than the 18 months currently recommended by the Centers for Disease Control and Prevention (CDC). Inter-pregnancy intervals (IPIs) less than 18 months have been associated with higher risks for mother and infant, including maternal mortality, preterm birth, low birth weight, small for gestational age, and infant mortality (Conde-Agudelo et al., 2006; de Weger et al., 2011; Hussaini et al., 2013; Huttly et al., 1992; World Health Organization, 2006). Specifically, a short IPI increases the risk for adverse neonatal outcomes through premature rupture of membranes, third trimester bleeding, and placental abruption (Conde-Agudelo et al., 2007; de Weger et al., 2011). Given that short IPI and overweight or obesity in pregnancy are associated with a similar risk profile, the preconception period is an opportune period in which to intervene to reduce risks which could be compounded by the presence of both (Davis et al., 2014).

For women who become pregnant for the first time, or subsequently conceive after the CDC-recommended 18 month interval, overweight and obesity are significant health concerns in pregnancy. According to the Centers for Disease Control and Prevention, obesity is the most common preconception condition among women (Johnson et al., 2006). Sixty percent of women in the U.S. enter pregnancy overweight or obese (i.e., pre-pregnancy BMI  $\geq 25$  kg/m<sup>2</sup>) (Guélinckx et al., 2008; Lee & Koren, 2010; Nodine & Hastings-Tolsma, 2012), and over 70% of women exceed the Institute of Medicine (IOM) recommendations for gestational weight gain (GWG) (Gould Rothberg et al., 2011; Simas et al., 2012; Stotland et al., 2006). Obesity during pregnancy and GWG exceeding IOM guidelines have been linked to short- and long-term health complications for both mother and infant (Al-Kubaisy et al., 2014; Gunderson et al., 2000; Oken et al., 2007; Siega-Riz et al., 2009; Stotland et al., 2006; Weight gain during pregnancy: Reexamining the guidelines, 2009). Excessive GWG is predictive of higher postpartum weight retention (PPWR) and an inability to return to pre-pregnancy weight within one-year postpartum (Siega-Riz et al., 2010) increasing the risk of long-term maternal weight gain (Ellison & Harris, 2000). For the infant, complications can

include intrauterine fetal death and stillbirth, fetal hypoglycemia (Gaillard et al., 2013), macrosomia, congenital abnormalities, and increased risk of childhood obesity (Oken et al., 2007). Additionally, children born to mothers who are obese have an increased risk of asthma and wheezing (Burstein et al., 2008; Denison et al., 2014; Gaillard et al., 2013, 2014; Galtier-Dereure et al., 2000; Harpoe et al., 2013; Hinkle et al., 2012). Yet, weight management during interconception is difficult for many women (Davis et al., 2014), highlighting the importance of this issue.

Managing stress is also critical for optimal health for women during their childbearing years. Stress is considered any uncomfortable emotional experience accompanied by predictable biochemical, physiological, cognitive, and behavioral changes (Baum, 1990). Pregnancy, childbirth, and parenting are accompanied by numerous physical (e.g., physical recovery, lack of sleep, fatigue, maternal birth injury, hormonal changes) and emotional stressors (e.g., fear of labor, changes in mood, relationship changes) for many women (Vesco et al., 2009). About 13–36% of women experience maternal stress during pregnancy (Kingston et al., 2012; Reynolds et al., 2013) that may exacerbate common pregnancy concerns (Stothard et al., 2009). Women who experience elevated levels of maternal stress during pregnancy may be more likely to have panic disorder, drug use, domestic violence, and multiple chronic health problems (Ovesen et al., 2015; Woods et al., 2010). Additionally, maternal stress may lead to depression and/or anxiety, poor/insecure attachment to child, decreased likelihood of breastfeeding (Verret-Chalifour et al., 2015), and may also contribute to negative behavioral changes such as lack of physical activity and poor diet (Hinkle et al., 2012; Masho et al., 2015; Nehring et al., 2013). Evidence of maternal stress in pregnancy on adverse neurodevelopmental outcomes for the child is substantial (O'Donnell et al., 2009) due to 'fetal programming' (DiPietro, 2004). A mother's stress exposure and her affective states in pregnancy may have significant consequences for her child's subsequent development and health (Beydoun & Saftlas, 2008; de Weerth & Buitelaar, 2005; Kinsella & Monk, 2009). Thus, stress management during the interconception period has the potential to reduce negative health implications for both mother and child.

Interconception weight and stress management were chosen as topics for this review specifically because these topics are so closely linked and are critical to the health and wellness of interconception women. More precisely, both weight and stress may be influenced by the expression of the other, making them interdependent. For example, difficulties managing stress may hinder weight management efforts during the interconception period (Huberty et al., 2013). Previous research has suggested a hormonal link in

which prolonged hypothalamic pituitary adrenal (HPA) axis activity results in elevated cortisol levels which in turn contributes to insulin resistance (Bjorntorp, 2001; Bjorntorp & Rosmond, 2000; Epel et al., 2000; Peeke & Chrousos, 1995; Raber, 1998). Specific to the interconception period, poor sleep quality and sleep loss due to a new baby's night waking may also contribute to the HPA axis alterations, which influence both sleep and obesity (Lucassen & Cizza, 2012). Lifestyle interventions for weight management often include strategies for managing stress (DPP Research Group, 2002); structured attempts to lose weight have the potential to reduce stress levels. Management of weight and stress during the interconception period are critical for maternal and child health, and each may be influenced by the other; thus, this review encompasses discussion of both stress and weight management in the interconception period.

The objectives of this manuscript are to (1) summarize the current state of knowledge regarding weight and stress management in the interconception period, (2) critically evaluate the research focused on the management of weight and stress during this period, and (3) provide future recommendations for research in this area. The authors of this manuscript are all members of the Women's Health Special Interest Group of the Society of Behavioral Medicine with specialized clinical and research interests in reproductive health. As such, the authors believe this specific topic is critical for improving health and wellbeing among women during key reproductive periods. Weight and stress are relevant to overall health and carry long-term consequences beyond the interconception period, for both the mother and the baby. Learning how to intervene during the childbearing years may positively impact lifetime trajectories of health.

While research has been plentiful on the intersection of weight and stress management both in general, and to some extent among postpartum women, this review contributes to the literature by addressing the specific considerations of women in the interconception period; women who have at least one child and will become pregnant again. It is these women who may be at highest need of interconception weight and stress management interventions as they struggle with the lack of time, energy, and motivation to pursue self-care activities while devoting time to caregiving of infants and young children, and in many cases, full time work. Health is paramount among this population as they will soon become pregnant again and poor weight and stress management may negatively affect fertility, pregnancy, birth outcome, and long-term health of the offspring. To our knowledge, no previous reviews have been published on this topic and the goal of this paper is to draw attention to the critical need for interventions for this population.

## Summary of current knowledge

### Weight management during the interconception period

Approximately one third of non-pregnant U.S. women aged 20–39 years old are obese and an additional 26% are overweight (World Health Organization, 2006). Rates of overweight and obesity are even higher for reproductive age African American and Hispanic women, at 75 and 65% respectively (Flegal et al., 2012). Together, this means that more than 50% of U.S. women enter pregnancy overweight or obese (Rasmussen & Yaktine, 2009). And more than 70% of women gain more weight during pregnancy than recommended by the Institute of Medicine (IOM), which has been linked with higher post-partum weight retention (Gould Rothberg et al., 2011; Simas et al., 2012; Stotland et al., 2006). Average PPWR ranges from 0.5 to 3 kg (ACOG Committee opinion no. 549: Obesity in pregnancy, 2013; Denison et al., 2014; Gaillard et al., 2013), but weight retention is quite variable (Linne & Rossner, 2003; Vesco et al., 2009), and up to half of women retain  $\geq 5$  kg (Linne & Rossner, 2003; Vesco et al., 2009). Additionally, some women gain weight in the year following childbirth (Conde-Agudelo et al., 2006).

Many overweight or obese women may not actively attempt weight loss during the interconception period (Lipsky et al., 2012) for reasons including feelings of futility given plans to conceive again in the near future, lack of understanding of the impact of maternal weight on future pregnancies, lack of recognition of their pregnancy intention given that more than half of pregnancies are unplanned, and lack of knowledge, skills and resources to manage weight (Devine et al., 2000; Montgomery et al., 2013). Postpartum women and women with young children have many barriers to health-promoting behaviors (e.g., physical activity, healthy eating) associated with weight management. In one recent study on barriers to physical activity faced by working parents, women cited barriers related to family responsibilities, guilt, lack of support, and time constraints (Mailey et al., 2014). In general, life events such as marriage, parenting, and occupational advancement have been associated with decreases in physical activity in young women (Brown & Trost, 2003). Women are more likely to report “tiredness” and “time” as barriers to health compared to men due to the presence of life events, which impact their health behaviors more than men (Ball et al., 2004). In a study of barriers to weight maintenance in women, those who had children scored lower than women in other living situations in regard to social support for physical activity as well as healthy eating (Andajani-Sutjahjo et al., 2004). Women with children are less likely to view “leisure time” physical activities as feasible (Ball et al., 2004).

### Stress management during the interconception period

Nearly one in five (18%) women report high stress in the year before a pregnancy (Beck et al., 2002). The experience of stress is often related to the presence of a stressor, an internal or external event that induces predictable biochemical, physiological, cognitive and behavioral changes (Baum, 1990) and is negatively associated with maternal health during the interconception period. Stress can impact maternal emotional health during the interconception period; if it is not managed early on, stress can become overwhelming and contribute to depression or anxiety disorders. Much of what we know about the presence of stress or stressors during the interconception period is through the link with the subsequent development of mood disorders. The presence of postpartum anxiety or depression has been associated with impairments in mothering, poor mother-infant interactions, and disrupted infant behavior and development (Novick & Flynn, 2013). Immediately post-partum and throughout the initial interconception period, stressors may include adjusting to motherhood, physical changes/body image concerns, marital relationship, lack of support, mood fluctuations, and returning to work.

Most stress management protocols geared towards perinatal women focus specifically on the prenatal period or the postpartum- the immediate aftermath of childbirth, and do not take into consideration women's needs as their children grow and they contemplate a subsequent pregnancy (Loomis & Martin, 2000). The interconception health promotion initiative (Loomis & Martin, 2000) was developed to provide intensive case management services to women who delivered a low birth weight infant to help them manage psychosocial stressors prior to a subsequent birth. The goals of the program were to foster the healthy, independent, mature, and productive side of the woman's psychological makeup in order to increase her internal resilience so that, despite environmental and/or personal obstacles, she could effectively use available resources. As this program focused on high-risk women who are living in poverty and was not rigorously tested, we cannot say with certainty that this approach should be disseminated to all interconception women; however, it is the only program that has been developed specifically to help women in the interconception period manage stress (Loomis & Martin, 2000). The PRAMS study examined stress in the interconception period without providing an intervention and found that of the women surveyed, prevalence of stress was highest in younger (<20) Black women whose most recent birth was a result of an unintended pregnancy. Conversely, women who were older (>35 years), White, and who had a past planned pregnancy and private insurance, were more

likely to have talked with a health-care professional regarding preparing for a healthy pregnancy and infant before they became pregnant with their new infant. This suggests that perhaps stress management interventions may be available in the interconception period, but only to a select group of women (Johnson et al., 2006).

### Inter-relationships between weight and stress management in the interconception period

It is important to address weight and stress management concurrently in the interconception period because together they pose additional risk to maternal and child health. Maternal stress is associated with significantly higher weight retention during the postpartum period (Pedersen et al., 2011). Continued stress following childbirth can contribute to further weight gain or failure to lose weight through behavioral factors, such as diet, exercise, and sleep habits (Dunkel Schetter, 2011). Stress is also responsible for neuroendocrine changes in which the hypothalamic pituitary adrenal axis (HPA) is activated and releases hormones, directly increasing the likelihood of adiposity and also increasing one's desire for unhealthy foods (Adam & Epel, 2007) leading to likely weight gain or failure to lose weight in the interconception period. Similarly, poor sleep has also been indicated in the relationship between obesity and HPA axis regulation (Lucassen & Cizza, 2012), which is especially relevant to our population of interest as infants and young children often cause sleep disruptions for their mothers. Among adults generally, stress can thwart attempts to adhere to a weight loss plan (Elder et al., 2012), yet weight loss has been associated with declines in stress levels (Elder et al., 2012). Additionally, retention of weight gain during pregnancy or weight gain in the interconception period can be stressful (Mannan et al., 2013; Pedersen et al., 2011).

When stress becomes chronic, women are at risk to develop serious mental conditions (i.e., depression) (Blackburn-Munro & Blackburn-Munro, 2001; Checkley, 1996; Staufienbiel et al., 2013), which has been linked to weight gain (Manber et al., 2008). Chronic stress and/or symptoms of depression may increase risk of becoming overweight or obese as a result of increased cortisol reactivity in response to emotional eating and lack of physical activity (Block et al., 2009; Chang et al., 2014). Hypercortisolemia (increased production of cortisol), may stimulate hunger, appetite and feeding (Talley, 2013; Whitaker et al., 2014) and may increase overeating during times of stress (Urizar et al., 2006). In addition, mothers who experience stress may exhibit poor lifestyle behaviors that negatively impact her energy, eating habits, weight, physical activity levels, and sleep (Manber et al., 2008).

Given the interrelated nature of stress and weight gain or retention due to the unique hormonal and emotional milieu of the interconception period, it seems that concurrent or combined interventions may be a recommended course of action for women who are between pregnancies.

### Critical evaluation of current state of knowledge

The goal of this review is to draw attention to the need for sustainable, efficacious, and integrated weight and stress management interventions for women in the interconception period. While there have been studies addressing components of each of these three goals, there have been no published studies describing a program that meets all of these needs. Limitations in the literature are plentiful, and are characterized below according to three major topics. These are (1) the lack of integration of stress and weight in published intervention studies (Salihu et al., 2012), (2) lack of studies related to the timing and feasibility for women's lives, (3) inconsistencies in the terminology and measures used to describe "stress", and (4) the limited inclusion of non-White populations which makes findings less generalizable.

#### No integrated stress and weight management programs

Currently lacking in the literature are studies that describe treatment models for an integrated weight loss and stress management program in the interconception period that are efficacious yet feasible and acceptable to women. While studies have been published describing weight and stress management protocols in postpartum women, it is notable how few studies explicitly address the *integration* of stress and weight management efforts.

While many lifestyle interventions include stress management components (DPP Research Group, 2002), little previous research has focused on how stress can act as a barrier to weight loss especially given hormonal fluctuations after delivery as well as emotional changes in the adjustment to new motherhood. Specifically, the interconception health promotion initiative seemed to be a great use of resources to help impoverished women deal with psychosocial stress; however, weight management was not addressed specifically in the interconception counseling (Loomis & Martin, 2000). Other studies have found that the ability to cope well with stress may play a larger role in weight management efforts than simply the presence or lack of stress itself (Gormally & Rardin, 1981; Grilo et al., 1989; Westenhoefer et al., 2004), which would then seem to warrant inclusion of stress management education and strategies in a weight loss program; however, this has not

been investigated in an interconception population. Similarly, while mind–body approaches seem especially well suited to address the interrelated nature of weight and stress management, studies of these techniques have not been implemented in interconception populations, despite evidence suggesting they would likely be effective and well received by the target audience (Currie et al., 2016).

#### Study timing and real world feasibility

The majority of the literature ends at completion of the postpartum period (i.e., 6–12 months post-delivery) yet the unique challenges related to weight and stress management in new motherhood continue beyond this period. Randomized controlled trials have demonstrated modest efficacy for lifestyle interventions among postpartum women, (Gaillard et al., 2014) yet interventions requiring numerous in-person sessions pose barriers to participation for many women (Carter-Edwards et al., 2009; Montgomery et al., 2011). Women have expressed a preference for mobile health solutions which would decrease the need for time consuming in-person assessments or attendance at intervention group or individual meetings. While research in weight management is rapidly taking advantage of technology, mobile or internet-based stress management interventions are only now in their infancy. Social media is in high use among young adults with many new mothers reporting having received parenting advice on social media within the last 30 days (Antheunis et al., 2013; Huberty et al., 2013; Lagan et al., 2010), however weight and stress management protocols have not taken advantage of this platform for increasing participant satisfaction and feasibility.

#### Inconsistent terminology and measures of stress

Another limitation of the current literature examining the impact of stress on weight loss after pregnancy is the inconsistent definitions and measurements of stress, including conceptualizing stress across varying domains (e.g., cognitive appraisals, physiological reaction, affective response). The limited existing research on the impact of stress on post-partum weight retention (Harris et al., 1999a, b; Walker, 1996, 1997; Whitaker et al., 2014) has used different measures to assess stress after pregnancy, such as the Parenting Stress Index (Abidin, 1995), the Perceived Stress Scale (Cohen et al., 1983; Cohen & Williamson, 1988), and the Stress Scale from Psychological Profile. This inconsistency limits the ability to compare findings across studies, as noted in a recent systematic review that examined the association between stress and PPWR (Xiao et al., 2014). Consistency in defining and measuring stress in the interconception period across studies would aid in

comparison and summarization of the literature in systematic review reviews and meta-analyses (Xiao et al., 2014).

### Limited inclusion of diverse populations

Finally, few studies have focused on pregnancy weight gain and postpartum weight loss differences specifically among women of different ethnic backgrounds, religious observances, and socioeconomic backgrounds (Headen et al., 2012; Rothberg et al., 2011; van Poppel et al., 2012; Walker et al., 2012). Therefore, expanded research efforts are also needed to identify barriers to weight or stress management in subgroups of women, such as racial/ethnic minorities and women with fewer economic resources. This is especially important as we consider that low-income, minority women are more likely to experience complications of pregnancy or birth (Kessel et al., 1988; Loomis & Martin, 2000) that may be targeted with combined interventions for weight and stress management in the interconception period. However, these women are less likely to actually seek out or attend programs such as these due to barriers including costs associated with transportation or childcare, lack of health insurance, and stigma related to seeking psychosocial support outside of the family or community (Headen et al., 2012; Wang & Beydoun, 2007).

### Recommendations for future research

We suggest three major areas for future research on weight and stress management during pregnancy and the interconception period: (1) integrated weight and stress management lifestyle interventions that simultaneously address strategies to manage postpartum weight loss and the psychosocial stress that accompanies childbirth and parenting (Salihu et al., 2012), (2) educational interventions for health care providers about the importance of weight and stress management during the interconception period; and (3) long-term studies that measure the public health implications of stress and weight management during the interconception period. Given the interrelated nature of weight and stress in the interconception period, identifying combined approaches that target the interplay of weight and stress management are warranted. Overall, we suggest that future research should span the full interconception period, define and assess stress consistently, and engage diverse patients, health care providers, and community stakeholders to develop and test efficacious approaches to manage stress and weight that meet women's needs in the interconception period.

### 1. Weight management lifestyle interventions

Future research should focus on expanding beyond the postpartum period throughout the entire interconception period. In particular, studies that address the relationship between weight and stress management, especially in the context of new motherhood, and guide tailored interventions specific to this time period are lacking and needed (Mailey et al., 2014). During motherhood, women prefer combined approaches for interventions that address a larger life context. For example, Kraschnewski and colleagues found that women preferred a program that promoted healthy behavior change through lifestyle modifications for them and their child over simply a diet and exercise program for themselves (2013). Given that new mothers want methods that are easy to use and don't require a time intensive commitment, we suggest two avenues to explore which have not been previously studied in interconception populations. First, combined mind-body techniques may streamline interventions by providing an integrated approach that targets the interrelated nature of weight and stress together. Second, the use of mHealth strategies to more readily integrate behavior change into women's busy lives in the interconception period.

### Mind-body approaches

Mind-body practices may be effective approaches for helping women manage weight and stress during the interconception period. Mind-body practices emphasize a whole systems perspective, specifically focusing on the interconnection between the mental, physical, emotional, spiritual, social and physiological aspects of our being (Rakel, 2006). These include practices such as yoga, tai chi, acupuncture, and meditation, which have often been recommended for stress management in addition to recommendations for increased physical activity (Barnes et al., 2004; Complementary, alternative, or integrative health: What's in a name?, 2008; Sharma, 2014). In a whole systems perspective, these benefits are synergistically linked together such that one domain affects another, just as research suggests that stress and weight are linked (Korkeila et al., 1998; Thomas et al., 2014). Mind-body practices emphasize how interactions between the mind, body, and behavior influence health (Beddoe & Lee, 2008) and have been proven to help individuals improve their diet and increase physical activity (Greene et al., 2009). This highlights the potential for mind-body practices to be effective in managing weight. There has been considerable growth in research on mind-body practices to improve health and wellness among pregnant and postpartum women (Gong et al., 2015; Zhang et al., 2015) and we

believe this could easily be translated to the interconception period.

While studies employing mind–body practices to manage weight during the interconception period are scant, findings in general populations using mind–body interventions for weight management appear promising (Bernstein et al., 2014). One study demonstrated a significant association between 30 min of weekly yoga (for  $\geq 4$  years) with an 18-pound lower weight gain among overweight participants after accounting for diet and physical activity (Kristal et al., 2005). Another study reported decreases in weight, body fat, body mass index, and waist circumference after a 16-week yoga intervention in postmenopausal women compared to a no-exercise group (Lee et al., 2012). Researchers also suggest that yoga may indirectly contribute to additional physical activity outside of yoga sessions due to reductions in low back and joint pain that typically hinders women from being active (Bernstein et al., 2014). Yoga may also improve mindfulness and mood by helping women feel more connected to the body, which enhances awareness of satiety and discomfort associated with overeating (Larkey et al., 2012).

Because mind–body practices focus both on addressing mental and physical health, they have the potential to decrease stress and improve weight outcomes simultaneously. The emphasis on self-care may have a positive impact on the mental and physical health (Beddoe & Lee, 2008) of interconception women who often report limited time and resources for self-care activities (Rhoades et al., 2016). In addition, mind–body practices may improve emotional self-regulation and awareness which may contribute to decreased stress and improved weight outcomes by increasing ones capacity to focus attention on physical needs (e.g., hunger/fullness cues, motivation for physical activity) (Larkey et al., 2014). These approaches may be more desirable to pregnant women because of the combined approach to health, and should be explored as a way to integrate weight and stress management efforts during this unique life stage. We recommend several avenues of research:

- *Strategies to disseminate mind–body practices to women in the interconception period, both broadly and in underserved populations.* First, research should address general needs to educate women about the content, types, and potential benefits of mind–body practices, and resources for accessing these approaches in their own communities. Discussion forums or support groups in which women can exchange knowledge and share resources may be effective. Second, research should address the dissemination of mind–body practices in lower income/education populations. Affordability is a particular concern. Dissemination via

public entities such as community centers and churches with sliding fee scales may not only improve access and affordability, but also mitigate cultural stigma about mind–body practices (e.g., perceived conflicts between yoga and religion). Additionally, online resources such as YouTube and other industry websites (e.g., online yoga or meditation webpages) may be user-friendly, and cost-effective resources.

- *Mechanisms of weight and stress management.* Determining the mechanisms by which mind–body practices can improve weight and stress during pregnancy and the interconception period is necessary yet largely understudied. There is a need for studies that examine efficacy of interventions and also observational and experimental research to elucidate the causal pathways and mediators linking mind–body practices and interconception health benefits.
- *Interventions to determine optimal dose of mind–body interventions.* The optimal dose of mind–body interventions such as yoga, tai chi, and qigong to improve weight, perceived stress, and maternal health have not been established in the literature. Future studies should test varied doses of mind–body practices to determine the minimal amount needed to see benefits on self-reported stress and weight loss. Research is also needed to examine the benefit of mind–body interventions to increase adherence to traditional lifestyle interventions, perhaps through the pathway of reducing stress that hinders attendance or engagement.

### Mobile health (mHealth)

Mobile health (mHealth) has emerged as a promising, low-cost mechanism with high population reach to deliver health behavior interventions (Boudreaux et al., 2014; Steinhubl et al., 2013). mHealth interventions may be a particularly good fit for women in the interconception period. Smartphone ownership is high among younger US adults; 86% of 18–29 year olds and 83% of 30–49 year olds own a smartphone (Anderson et al., 2015). Nearly three-quarters (73%) of online US adults use social media, and 42% have accounts on multiple platforms. Facebook is the most prevalent online social network currently; 71% of online US adults use Facebook (Duggan et al., 2015a), with higher rates among younger adults and new parents. Many women seek support from their online networks; 83% of mothers report getting useful information on Facebook and half reported receiving social or emotional support on a parenting issue in the past 30 days (Duggan et al., 2015b). Though many postpartum women desire programs they can access anywhere/anytime via the Internet and mobile devices (Hearn et al., 2013; Walker et al., 2012), few

interventions exist utilizing mHealth for weight and stress management during the interconception period. The potential reach of mHealth interventions and opportunity to collect real-time data warrants future studies in this area related to the following:

- *Interventions that address stress management in real-time.* Mobile phone and text messaging (SMS) interventions (e.g., using an app to practice breathing or meditation) could meaningfully enhance women's skills within the real-life context of stressful situations. Techniques such as ecological momentary assessment (EMA) are designed to collect moment-by-moment data in real-world settings and may be a unique strategy to identify stress and mental health patterns throughout the interconception period.
  - *Interventions that utilize mHealth as part of a comprehensive approach for weight and stress management during the interconception period.* mHealth could be used in weight and/or stress management interventions as a tool to enhance communication and follow-up with women in the interconception period. Providing women with regular mobile 'check-ins' and reminder text messages may be beneficial in improving adherence and satisfaction to programs. mHealth approaches to weight management in the interconception period would also allow women to interact with other mothers, sharing their experiences and receiving support, which may reduce stress in this life period, especially stress due to parenting.
2. Educational interventions for health care providers about the importance of weight and stress management during the interconception period.

Educational interventions are needed that improve health care providers' knowledge and skills related to healthy weight and stress management in the interconception period. A majority of women indicate that their health care providers greatly influence their beliefs about behavior change, and that brief behavioral change counseling by providers increases the likelihood of adopting perinatal health behaviors (Aittasalo et al., 2008; Krans et al., 2005; Leiferman et al., 2014). As influential sources of information, health care providers may play an integral role in promoting healthy lifestyle behaviors throughout the interconception period. Although a majority of providers strongly believe in engagement in health behaviors which contribute to optimal weight, such as regular physical activity, healthy eating and stress management is important, many lack the knowledge, skills, and confidence needed to provide guidance on these behaviors (Leiferman et al., 2012). In turn, patients report information obtained

from their health care providers is often inconsistent or lacking (Leiferman et al., 2011, 2014), underscoring opportunities to improve patient-provider communication. Additionally, patients report little to no assessment of stress by their providers, and a lack of follow-up involving guidance to manage stressors and seek further evaluation/intervention. Establishing effective communication between primary providers and mental health specialists is a critical piece of this process.

In summary, there is a need to develop future interventions to increase providers' knowledge and skills to effectively counsel patients on weight and stress management during the interconception period. Future work should focus on improving providers' ability to identify women who are in need of weight and stress management, provide guidance based on evidence-based practices, utilize linkages to community resources and mental health specialists, and understand ways to enhance patient-provider communication. Specific recommendations include:

- Enhance providers' awareness of current professional guidelines relevant to counseling women in the interconception period related to weight and stress management. Many providers are unaware or fail to follow current professional guidelines related to stress management (Nerurkar et al., 2013); thus, may be less likely to deliver a consistent message based on evidence-based practices. Enhancing providers' awareness of current guidelines is the critical first step in enhancing patient-provider communication on weight and stress management. Furthermore, there is a need to increase the likelihood that providers will follow guidelines and discuss weight and management with their patients. Recent evidence suggests that 30–40% of pregnant women report that their provider did not discuss weight management with them (Phelan et al., 2011; Waring et al., 2014).
- Enhance providers' awareness and use of screening tools for stress in clinical practice. Findings suggest providers are willing to use screening tools in their practices (Leiferman et al., 2008). Future research should determine effective ways to disseminate and integrate screening protocols into practice flow including the use of electronic health record data as well as link to treatment and referral options. Screening, Brief Intervention, Referral to Treatment (SBIRT) is a framework that has shown to be very effective for substance use (Agerwala & McCance-Katz, 2012) that may be a potential model for future work related to stress management.
- Increase providers' confidence in talking with patients about weight and stress management. Most providers understand the benefits of weight and stress manage-



ment but often report a lack of confidence in providing guidance to their patients. Providers sometimes perceive patients, especially overweight/obese women, as not always being receptive to counseling on weight and many providers lack confidence in how to approach these sensitive issues with their patients (Stotland et al., 2010).

- Moreover, providers often report a lack of confidence in talking with patients about stress management (Avey et al., 2003). Use of motivational interviewing techniques have been shown to be successful in improving patient-provider communication and may help to facilitate these often difficult conversations (Elder et al., 1999; Rubak et al., 2005).
  - Encourage providers to leverage community resources designed to promote weight and stress management. There is an inherent tension between a stressed healthcare system and asking providers to do more in a limited amount of time. Identifying and leveraging extant resources within communities may help to reduce this burden. Identifying and accessing evidence-based community interventions and linking these resources to our healthcare systems are key to this process. For example, Weight Watchers has a strong evidence for both short and long term weight loss (Heshka et al., 2003; Madigan et al., 2014; Mitchell et al., 2013) and is widely available via 40,000 meetings weekly in all 50 US states, interactive website, and mobile application (Madigan et al., 2014); the focus on community and support through this program could also help women manage stress during this life period.
3. Long term studies that examine the public health implications of interconception weight and stress management.

The importance of stress and weight management in the interconception period and development of interventions for these problems is a burgeoning field and would benefit from long-term detailed information about the effects of weight and stress on mothers and children during this critical period. Longitudinal data on interconception weight management are needed to provide information on medical or mental health treatment decision making in clinical settings. Additionally, long-term follow up studies provide useful information on the feasibility of a treatment or intervention once the active study period has been completed. This is imperative in areas of lifestyle modification, such as implementing a weight and/or stress management plan, which requires long-term maintenance in order to see sustained improvements. In a recent review of 45 commercial weight loss programs (Gudzune et al.,

2015), only two had longer than a 12-month follow-up period evaluating longer-term weight loss, highlighting the need for long-term weight loss interventions in general and especially during the postpartum and interconception periods. Longitudinal studies may:

- Assess the efficacy and effectiveness of weight management methods during the interconception period. Intervention development should consider potential for implementation, and research programs should plan dissemination and evaluation phases in order to maximize public health benefits.
- Examine the longer-term health impact of interventions to manage stress and weight in the interconception period; health consequences should include medical and/or psychological effects on mother and child. In order to measure the public health impact of new approaches to interconception care, comparison groups receiving standard care will be necessary. Both traditional and pragmatic randomized controlled trials are needed to determine whether new approaches are effective in helping women remain healthy during interconception periods.
- Examine the neuroendocrine and physiological changes that lead to weight retention during the interconception period, which should be undertaken as a way to highlight issues that are specific to women at this reproductive stage.

## Summary and conclusion

Both stress and excess weight in the interconception period can complicate future pregnancies and thus management of stress and weight during the interconception period is critical for maternal and child health – yet these pose challenges for women. Stress can hinder attempts to lose weight following childbirth by contributing to hormonal changes which increase adiposity and behaviors such as overeating. Further, retention of weight gained during pregnancy or further weight gain after delivery can increase stress in the interconception period. Research has established the importance of a healthy weight and low stress during the reproductive years and the impact of overweight and high stress levels on maternal and child health outcomes. However, combined evidence-based treatment models that address postpartum weight loss and stress management during the interconception period are lacking. This problem is further compounded by inconsistent definitions and measurement of stress during the postpartum period. Various recommendations for future research focus are made including interventions that incorporate mind–body practices and mHealth, interven-

tions that target enhancement of healthcare providers' understanding of the significance of weight and stress management during the interconception period, and long-term follow-up studies that focus on the public health implications of weight and stress management during the interconception period. In light of increasing obesity rates across the nation, chronic disease outcomes will reach epidemic proportions requiring integrative, comprehensive care. Addressing excess weight and stress during the interconception period via a reproductive lens will be a starting point for women and their families to live long and healthy lives.

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#### Compliance with ethical standards

**Conflict of interest** Jennifer Huberty, Jenn A. Leiferman, Abbey R. Kruper, Lisette T. Jacobson, Molly E. Waring, Jeni L. Matthews, Danielle M. Wischenka, Betty Braxter, and Sara L. Kornfield declare that they have no conflict of interest.

**Human and animal rights and Informed consent** All procedures followed were in accordance with ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000. Informed consent was obtained from all patients for being included in the study.

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