

Maternal Behavioral Health: Fertile Ground for Behavior Analysis

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Published online: 10 May 2018

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Abstract The World Health Organization has identified four behavioral health priorities as risk factors for noncommunicable diseases in maternal populations: tobacco use, harmful alcohol use, poor nutrition, and lack of physical activity. These risk factors also significantly affect pregnant and immediately postpartum mothers, doubling the health risk and economic burden by adversely affecting maternal and birth or infant outcomes. Psychosocial and behavioral interventions are ideal for pregnant and immediately postpartum women as opposed to pharmacotherapy. Among other behavioral interventions, the use of incentives based on the principles of reinforcement has been a successful yet controversial way to change health behaviors. Implementing an incentive-based intervention in maternal health often brings up social validity concerns. The existing guideline on how to develop and conduct research in incentive-based interventions for maternal health lacks enough information on the specific variables to control for to maintain the intervention's effectiveness. This article outlines some of the critical variables in implementing an effective behavior-analytic intervention and addressing social validity concerns to change maternal behaviors in a sustainable manner, along with specific research topics needed in the field to prevent adverse maternal, birth, and infant outcomes.

Keywords Health incentives · Maternal and infant health · Smoking · Drinking · Breastfeeding · Behavioral health research

Around the world, 35 million people annually die from noncommunicable diseases, including cancers, cardiovascular diseases, chronic respiratory illnesses, and diabetes—

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all costly but preventable—with noncommunicable diseases being, so far, the leading causes of death (World Health Organization [WHO] NCD Alliance, 2011). The primary causes of death in women (causing more than 1 million deaths) in 2008 were cardiovascular diseases, infectious and parasitic diseases, cancer, respiratory diseases and infections, unintended injuries, and perinatal conditions (WHO NCD Alliance, 2011). These are costly to society because of the combination of medical costs, costs of transportation to and from health services, time associated with informal caregiving, and lost productivity (WHO NCD Alliance, 2011). Given the significant role of women in families, loss of women can result in further poverty, higher mortality among children, food insecurity, and children being withdrawn from school (WHO NCD Alliance, 2011). The WHO identified four main risk factors contributing to these causes of death: (a) tobacco use, (b) harmful use of alcohol, (c) unhealthy diet, and (d) lack of physical activity (WHO NCD Alliance, 2011). If pregnant or immediately postpartum women are exposed to these four risk factors, there are significant health effects on the pregnancy and the health of the mother and the offspring (Aliyu et al., 2008; Bailey, McCook, Hodge, & McGrady, 2012; Bartick et al., 2017; Catalano & Shankar, 2017; Dupraz, Graff, Barasche, Etter, & Boulvain, 2013; Yeo, Walker, Caughey, Ferraro, & Asafu-Adjei, 2017). The economic consequence of exposure to these risk factors (use of tobacco, use of alcohol, unhealthy diet, and lack of exercise) is not trivial (Bartick, 2011; Florence, Adams, & Ayadi, 2007; Popova, Lange, Burd, & Rehm, 2012). Efficacy and safety of pharmacological treatment for treating prenatal tobacco or alcohol use have not been established (Coleman, Chamberlain, Davey, Cooper, & Leonardi-Bee, 2015; Smith, Lui, & Terplan, 2009). Nonpharmacological interventions include psychosocial approaches that address environmental, psychological, and social factors to promote healthy environments and behaviors (Gamble & Hart, 2003). Not all psychosocial interventions target behavior change, and some focus on providing educational information, assessment, and social work support (Gamble & Hart, 2003). A combination of psychosocial and behavioral interventions is often designed to address a complex interplay of these factors in assisting mothers and families (Chapman & Pérez-Escamilla, 2012; Patnode et al., 2015; Rasmussen et al., 2012). The following section summarizes the psychosocial and behavioral interventions tested to address these risk factors in maternal (pregnant and immediately postpartum) populations.

Psychosocial and Behavioral Interventions to Address Risk Factors

Tobacco Use

Maternal smoking during pregnancy increases the risk of miscarriage, low birth weight, preterm delivery, and health problems leading to admission to the neonatal intensive care unit (Adams et al., 2002; Bailey et al., 2012; Janisse, Bailey, Ager, & Sokol, 2014). In addition to the risks of maternal smoking during pregnancy, passive exposure to parental smoking increases the child's risk of sudden infant death syndrome, asthma, altered respiratory and cardiovascular function, infection, behavior problems, sleep difficulties, and cancer (Treyster & Gitterman, 2011). In 2015, 14% of pregnant women in the USA reported using tobacco (Substance Abuse and Mental Health Service

Administration [SAMHSA], 2015). During 2011 and 2012, two out of every five children ages 3 to 11 in the USA were exposed to secondhand smoke on a regular basis (Centers for Disease Control and Prevention [CDC], 2015).

Psychosocial and behavioral interventions to address maternal smoking range from brief counseling to comprehensive psychosocial support (Chamberlain et al., 2017; Logan, Rothenbacher, & Genuneit, 2017; Risica, Gavarkovs, Parker, Jennings, & Phipps, 2017). Addressing smoking during pregnancy, counseling, feedback, and provision of incentives were effective in increasing smoking abstinence rates according to a recent meta-analysis (Chamberlain et al., 2017). Postpartum smoking relapse rates are high. Although various approaches are being explored, more research is needed to support postpartum smoking cessation or relapse prevention (Allen, Allen, Lunos, & Tosun, 2016; Feeney & Britton, 2016; Logan et al., 2017; Pollak et al., 2016).

Alcohol Use

Prenatal exposure to alcohol can cause a broad range of adverse developmental effects, including congenital defects, intellectual neurodevelopmental disabilities, and fetal alcohol spectrum disorders (American Academy of Pediatrics [AAP], 2015). Recent evidence shows that should mothers decide to breastfeed, maternal alcohol consumption during postpartum periods can influence infants' health outcomes, including weight, verbal IQ, and developmental anomalies (May et al., 2016; Tay et al., 2017). In 2015, 9% of pregnant women in the USA reported a level of alcohol use (SAMHSA, 2015).

Psychosocial and behavioral interventions for reducing alcohol consumption among pregnant women and women planning to get pregnant include educational sessions, motivational enhancement therapy, self-help groups, psychotherapeutic techniques, and cognitive-behavioral interventions (Stade et al., 2009). So far, limited evidence exists regarding the effect of psychosocial and behavioral interventions on reducing alcohol use in maternal populations (Lui, Terplan, & Smith, 2008; Stade et al., 2009). A small community-based pilot study showed that the use of incentives contingent on alcohol abstinence helped pregnant women maintain alcohol abstinence during pregnancy (Washio, Archibald, Frederick, & Crowe, 2017).

Healthy Lifestyle

Particularly concerning for mothers with unhealthy nutrition and lack of exercise are the issues of maternal nutrition, weight gain, and breastfeeding (Catalano & Shankar, 2017; Ip et al., 2007; Rahman et al., 2016; Yeo et al., 2017). Maternal anemia during pregnancy is a great concern for mothers from low- to middle-income countries (Rahman et al., 2016). However, historically, the focus has been on developing behavioral interventions to manage overweight and obesity in pregnant and postpartum women (Catalano & Shankar, 2017; Jaacks, Kavle, Perry, & Nyaku, 2017; Magro-Malosso, Saccone, Di Mascio, Di Tommaso, & Berghella, 2017; Yeo et al., 2017).

Physical exercise interventions ranging from walking to aerobic exercise for overweight and obese pregnant women have helped to significantly reduce the incidence of gestational diabetes; however, these have not had a consistent impact on preventing adverse birth outcomes (Magro-Malosso et al., 2017). Nutritional and exercise

counseling delivered by prenatal care providers compared with that provided by others has made significant improvements in controlling gestational weight gain among overweight and obese pregnant women (Yeo et al., 2017).

Mothers are advised to exclusively breastfeed their infants during the baby's first 6 months of life, with any level of continued breastfeeding occurring at least through the first year (AAP, 2012). Suboptimal breastfeeding increases the risk for infant mortality during the first 6 months (NEOVITA Study Group, 2016). In addition, suboptimal breastfeeding can put an infant at risk for a variety of pediatric infectious diseases, including otitis media, gastroenteritis, and respiratory infections (U.S. Department of Health and Human Services, 2011), and can put the mother at risk for maternal postpartum weight retention (Dewey, Heinig, & Nommsen, 1993), Type II diabetes, depression, and breast and ovarian cancer (Beral, Bull, Doll, Peto, & Reeves, 2002; Chowdhury et al., 2015; Dewey et al., 1993; Rosenblatt & Thomas, 1993). Infants who are exposed to excessive formula feeding are at risk for excessive infant weight gain as well as childhood overweight and obesity (Boone-Heinonen, Messer, Andrade, & Takemoto, 2016; Sinigaglia, Ríos, Campos, Díaz, & Palacios, 2016; Smithers, Kramer, & Lynch, 2015). This culturally supported tradition of excessive formula feeding maintains a generational cycle of weight management issues.

Institutional breastfeeding support has successfully increased the initiation rate (Philipp et al., 2001); however, encouraging mothers to continue breastfeeding for 6 months has been a challenge, especially among socioeconomically disadvantaged mothers (Chapman & Pérez-Escamilla, 2012). Peer support has been the most promising component to increase continued breastfeeding rates (Chapman & Pérez-Escamilla, 2012; Howell, Bodnar-Deren, Balbierz, Parides, & Bickell, 2014). Recent evidence shows that breastfeeding rates have significantly increased as a result of combining peer support with incentive use (Washio, Humphreys, et al., 2017).

Behavioral interventions using reinforcers or contingent incentives were developed based on behavior–analytic principles (Higgins, Silverman, & Heil, 2008; Miller, Meyers, & Hiller-Sturmhöfel, 1999). These behavioral interventions have been shown to be promising in reducing health risk factors (Higgins et al., 2012; Washio, Archibald, et al., 2017; Washio, Humphreys, et al., 2017). When financial incentives are used in behavioral interventions, they function as reinforcers. These financial incentives have been effectively used to promote a health behavior change across different behaviors and populations (Cahill, Hartmann-Boyce, & Perera, 2015; Chamberlain et al., 2017; Gardiner & Bryan, 2017; Higgins et al., 1993, 2012; Moran et al., 2015; Paul-Ebhohimhen & Avenell, 2008; Pettifor, MacPhail, Nguyen, & Rosenberg, 2012; Raftery, Kerr, Hawker, & Powell, 2009; Stanton, Higgs, & Koblinsky, 2013; Till, Everetts, & Haas, 2015; Volpp et al., 2008; Washio, Archibald, et al., 2017; Washio, Humphreys, et al., 2017; Witter, Fretheim, Kessy, & Lindahl, 2012). The following are examples of populations and behaviors addressed with incentive use: drug and alcohol abstinence (Higgins et al., 1993; Washio, Archibald, et al., 2017), smoking cessation in pregnant and nonpregnant populations (Cahill et al., 2015; Chamberlain et al., 2017), fruit and vegetable consumption (Gardiner & Bryan, 2017), breastfeeding (Moran et al., 2015; Washio, Humphreys, et al., 2017), weight loss (Paul-Ebhohimhen & Avenell, 2008; Volpp et al., 2008), HIV prevention (Pettifor et al., 2012), improvement in clinical practice (Raftery et al., 2009), and health service delivery for maternal and child health as well as for that of general populations (Witter et al., 2012). Also,

nonfinancial contingent incentives have been valuable in promoting health behavior change, including reinforcement from gaming activities (Kamboj & Krishna, 2017), prize draw opportunities (Petry, Alessi, & Ledgerwood, 2012), deposit reimbursement (Paxton, 1983), and community donations (Amass & Kamien, 2004). Incentives can simply be the commodities that the population prefers and finds reinforcing (Kelley & Wine, 2016; Kerwin, Farris, & Hantula, 2012). Recent evidence shows that contingent financial incentives improve targeted maternal health behavior (Higgins et al., 2012; Washio, Archibald, et al., 2017; Washio, Humphreys, et al., 2017). Also, noncontingent financial assistance has been shown to improve overall pregnancy and birth outcomes (Brownell et al., 2016). The following section summarizes the approach followed by the current climate and the development of incentive-based behavioral interventions within the field of maternal health.

Incentive-Based Behavioral Interventions with Contingent Incentives in Maternal Health

Adherence to basic principles contingency management includes ensuring the magnitude of reinforcers, monitoring frequency, and immediacy of providing reinforcers after behavioral occurrence (Higgins & Petry, 1999; Lussier, Heil, Mongeon, Badger, & Higgins, 2006). Use of contingency management has resulted in favorable outcomes in changing maternal health behavior (Donatelle et al., 2004; Higgins et al., 2012; Schottenfeld, Moore, & Pantalon, 2011; Washio, Archibald, et al., 2017; Washio, Humphreys, et al., 2017). Behavioral interventions using incentives will be called *incentive-based interventions* hereafter.

Other research using incentives has shown mixed or unclear results in actual behavior change, and many studies have failed to objectively verify the behavior that is being reinforced (Moran et al., 2015; Morgan et al., 2013; Rasmussen et al., 2012). Part of the challenge with implementing an incentive-based intervention in maternal behavior change is the concern of social validity. The concern over social validity pertains to varying attitudes about using incentive-based interventions to promote individual behavior change as an acceptable way to improve public health (Furman, 2017; Klein, 2014; Morgan et al., 2013; National Institute for Health and Care Excellence, 2010; Raftery et al., 2009; Working Group on Incentives for Living Donation, 2012). In other words, social validity is directly relevant to the dissemination of innovative interventions and the development of appropriate community-based technologies (Winett, Moore, & Anderson, 1991).

The National Institute for Health and Clinical Excellence (NICE) in the United Kingdom provided evidence-based recommendations for using incentives to promote health change (NICE, 2010). However, approximately 38% of the council members voted against using incentives under any circumstance. These council members' objections to the use of incentives included the following: cost, potential abuse, lack of empirical evidence, rationale for having to pay adults to make health decisions, and a belief that it is unfair for others to make appropriate decisions (NICE, 2010). However, others supported the use of incentives by making them part of a larger comprehensive benefit package and targeting vulnerable populations, including children and pregnant women (NICE, 2010).

The direction of this conditional agreement to use incentives for maternal health is consistent with the concern raised by the Lancet Commission in 2015 about women in the health-care workforce, either at home or in the workplace. The Lancet Commission stated that women are significantly underrecognized and undercompensated for their social, biological, and occupational contributions to health improvement (Langer et al., 2015). A report based on the U.S. Government Evidence Summit on Enhancing Provision and Use of Maternal Health Services through Financial Incentives convened in 2012 (Stanton et al., 2013) provided comprehensive reviews of existing evidence on incentive use for maternal and infant health. Authors provided reviews on incentive use for both patients and providers and concluded that more evidence on the effect of incentive use on actual health outcomes is necessary and that increased collaborations among maternal health experts, program designers, economic experts, and financial stakeholders are desirable to appropriately design a cost-effective incentive program (Stanton et al., 2013).

A guideline has been developed on how to strengthen the research on incentive-based interventions for maternal health improvement. The guideline describes how to increase the scientific rigor in study designs, evaluating the effect of long-term incentive use, incorporating qualitative methods of sustainable implementation, identifying priority populations that benefit the most from incentive use, using incentives for providers' performance, conducting cost-effectiveness analysis, and preventing unintended adverse consequences such as stigma (Morgan et al., 2013). Also, this guideline emphasizes the importance of controlling the variables that affect the impact of incentive effects; however, this part was brief and not spelled out in the actual list of control variables (Morgan et al., 2013).

Protecting maternal populations from unintended adverse consequences is a consistent social validity challenge to overcome. Also, it is difficult to sustain such an approach in a society that is not used to "paying" clinical populations for health behaviors that they should already be engaging in by their sheer will (Rocca, 2017). There may be less criticism for encouraging mothers to improve their health behaviors (e.g., breastfeeding, health visits; Furman, 2017; Langer et al., 2015) rather than abstaining from unhealthy behaviors (e.g., smoking cessation, abstinence from substance use; Rocca, 2017). The potential health-care costs for suboptimal health in mothers and children can be enormous, and many long-term issues affecting mothers and their children can be prevented if care is delivered during pregnancy and early postpartum (Bartick, 2011; Max, Sung, & Shi, 2015; Popova et al., 2013). In addition, pregnancies do not typically extend beyond 40 weeks, and adherence to postpartum behaviors such as the use of prescription contraceptives (Heil et al., 2016) and breastfeeding (Washio, Humphreys, et al., 2017), even for a short period of time, can result in enormous health benefits. The time-limited opportunity to maximize the health and economic benefits of a behavior-analytic intervention should be in service of behavior analysts' values. The behavior-analytic community can demonstrate to society the benefits of scientifically and economically investing in improving maternal health behaviors. This community can investigate biological, psychological, environmental, and social variables associated with target health behaviors and the population, demonstrate efficacy and cost-effectiveness, and appropriately communicate and disseminate an effective approach (Rimer, Glanz, & Rasband, 2001; Winett et al.,

1991). However, we must first discuss some ways to improve maternal health using a behavior–analytic intervention that simultaneously addresses some of the relevant social validity issues.

Tips on Behavioral Interventions for Maternal Behavior Change

Community Buy-in

The idea of paying mothers for health behavior change has generated controversy. Demonstrating the effect of a behavior–analytic intervention in an isolated setting has been the traditional way; however, this application ends up creating continuous resistance from society in accepting the approach when the application is ready to be disseminated. There are a number of barriers to implementing a behavior–analytic intervention in a community setting. Some of these barriers include perception and acceptability among clinicians and other stakeholders, collaboration with clinicians and other stakeholders, knowledge and self-efficacy among clinicians, competition with clinical priorities, procedural complexity or burden, structural and economic constraints, flexibility to pilot and adjust, and cost (Hartzler, Lash, & Roll, 2012). Thus, finding an existing community setting that includes the target maternal population and that buys into a behavior–analytic intervention not only helps to test the effect of an intervention but also lays a path to implement and sustain the approach in a real-world setting. At that point, it is no longer behavioral scientists fighting their way in society but a group of community members that support a valuable intervention in society, and incentive-based interventions tested in a community setting have been effective (Brownell et al., 2016; Washio, Archibald, et al., 2017).

Should an intervention prove its effectiveness, a group of community members including behavioral scientists could then have productive conversations on how to sustain the approach. This conversation should include the following issues: Who monitors the behavior, how to monitor the behavior, how frequently to preserve the source of reinforcement, and how to preserve the source of reinforcement (Washio, Archibald, et al., 2017; Washio, Humphreys, et al., 2017). An intervention that focuses on individual behavior changes works at the intrapersonal level; however, any member of society also exists at the interpersonal, organizational, and community levels (Rimer et al., 2001). It is critical to conduct postintervention formative research (e.g., individual interviews with open-ended questions, focus groups) to receive input from relevant stakeholders to identify the appropriate setting and the steps to disseminate an intervention within the existing community infrastructure (Winett et al., 1991). The key is to let stakeholders guide ways to implement and disseminate an intervention approach so that the intervention is considered only supplemental and beneficial to the existing infrastructure (Winett et al., 1991). In our limited experience, community members have suggested working in tandem with a nonprofit organization to raise funds for the cost of reinforcement and staffing and to negotiate with insurance companies for reimbursement upon health behavior change. Our associated community members have also volunteered to deliver the intervention after the study period (Washio, Archibald, et al., 2017).

Focus on Target Behavior

No matter how flexible behavior analysts try to become to target social validity, it is still imperative to protect objectivity in the definition of a target behavior so that one does not end up reinforcing irrelevant behaviors. Target health behaviors, including smoking, substance and alcohol use, physical activity, and breastfeeding, often occur in the absence of monitoring individuals and therefore are not directly observable. As a substitute for directly observable behaviors, evidence that individuals abstain from substance, alcohol, and tobacco use or engage in physical activity can be collected to objectively verify the occurrence of target behaviors. In the case of substance, alcohol, and tobacco use, biochemical verification has been successfully used to reinforce abstinence (Barnett, Tidey, Murphy, Swift, & Colby, 2011; Higgins et al., 2008, 2012). Physical activity can be monitored using accelerometers (Kurti & Dallery, 2013; Washington, Banna, & Gibson, 2014), and weight loss measurement has also been used to demonstrate lifestyle changes as a result of an increased level of physical activity (Volpp et al., 2008).

Certain maternal behaviors are considered “private” (e.g., breastfeeding and the use of contraceptives; Heil et al., 2016; Washio, Humphreys, et al., 2017); however, as long as behavior occurs, you can find an appropriate setting (e.g., private settings such as home settings; Washio, Humphreys, et al., 2017) and identify closely associated behaviors (e.g., attendance to follow-up support; Heil et al., 2016) to verify the occurrence of target behaviors. However, some maternal behaviors such as breastfeeding can have multiple dimensions when trying to pinpoint target behaviors (Washio, Humphreys, et al., 2017). A clinician may have to temporarily adjust the definition of target behavior so that it is simple and nonthreatening for a mother to demonstrate until the mother becomes used to engaging in the behavior.

Monitoring of Behavior

Some maternal behaviors such as substance and alcohol use need to be regularly monitored on a frequent basis to prevent relapse (Higgins et al., 2012; Schottenfeld et al., 2011; Washio, Archibald, et al., 2017). Other behavior, such as breastfeeding, does not require frequent monitoring (i.e., daily practice needed for adequate milk production and successful latching by an infant). It is often not feasible for mothers with multiple family responsibilities and psychosocial issues stemming from substance and alcohol use to see a clinician on a regular basis. A clinician’s involvement in monitoring and delivering incentives might not always be ideal. The presence of a clinician may become aversive when a patient is not engaging in a target behavior (Higgins et al., 2008). Home visitation programs with nurses or paraprofessionals have been developed to address this issue (Olds et al., 2014). Mobile technology has also been effectively used to provide frequent monitoring opportunities without in-person visits (Alessi & Petry, 2013; Meredith, Grabinski, & Dallery, 2011). Use of mobile technology not only helps reduce the burden on the target population but also helps providers effectively manage their time for service.

Frequent monitoring can be perceived favorably by mothers if the requirement to earn a reinforcer is realistic and easy to achieve—at least initially—until they become comfortable with contingencies (Heil et al., 2016; Higgins et al., 2012; Meredith et al.,

2014; Washio, Humphreys, et al., 2017). The requirement can change based on topographies or dimensions of behavior. Some examples of these changing criteria may include that, initially, an infant latches onto the breast for any duration of time; however, over time, the requirement may become latching on for a specific duration of time. Another example of shaping a precursor behavior into a target behavior is testing initially for carbon monoxide in breath samples but later testing for cotinine levels in urine samples with a longer detection period of smoking (Cooper, Heon, & Heward, 2007).

Functional Relationship

One needs to frame a verbal instruction in describing a contingency to a mother to develop her confidence and prevent her from feeling threatened that she may be perceived as a “failure” when she does not engage in a target behavior. When giving verbal instruction, it is important not to use threats or reprimands (e.g., “You should be breastfeeding or you won’t get the incentive”; “You are not smoking, are you?”). It is recommended that clinicians repeatedly emphasize that they are there only to help the mother and that they understand the challenge that the mother has to face (e.g., “I know that you are doing your best, but there is a lot going on in your life. We are doing this program to help you, not judge you. We also want you to look forward to receiving incentives”). Using supportive language prevents the target population from associating the clinician’s presence with feelings of failure and guilt.

It is difficult to convince society to provide financial incentives for reinforcing behaviors associated with stigma, such as substance and alcohol use. As we know that it is not the content of a reinforcer itself but the functional relationship that makes a contingency effective, we can substitute financial incentives with other stimuli or events that are relevant and reinforcing to the target population. Although providing financial incentives for prenatal alcohol abstinence has been harshly criticized (Rocca, 2017; Washio, Archibald, et al., 2017), an approach that provided social work assistance based on mothers’ needs has been shown to be feasible and acceptable for both the target population (i.e., socioeconomically disadvantaged, mothers who use substances and alcohol) and society and has been disseminated internationally (Grant, Ernst, Pagalilauan, & Streissguth, 2003; Rasmussen et al., 2012). Instead of receiving financial incentives, this target group received the following: linkage to care for mental health issues, linkage to care for substance and alcohol use, and assistance with childcare, housing, relationship, legal, medical, and employment issues. Another example that is behavior-analytic in nature is the community reinforcement approach. In the community reinforcement approach, individuals are assisted with engaging in naturally occurring behavioral contingencies through a healthy social network, recreational activities, and employment and have opportunities to obtain reinforcers such as social reinforcement, salary, and pleasure in natural environments (Miller et al., 1999).

Another challenge to implementing an incentive-based intervention is establishing social validity and determining the effective magnitude of a reinforcer to motivate behavior change. What qualifies as socially valid and highly reinforcing depends on the needs and socioeconomic status of the target population. It has been shown that an incentive as small as a few dollars can affect the choice behavior in a substance-dependent population in a laboratory setting (Higgins, Bickel, & Hughes, 1994).

Therefore, successful interventions assess the list of needs of the participant as the source of reinforcement at treatment entry (Ernst, Grant, Streissguth, & Sampson, 1999) and empirically determine the magnitude of a reinforcer based on a pilot study or direct input from the target population (Washio, Humphreys, et al., 2017).

Research Design

Behavior analysts traditionally use single-subject design as the major research design to conduct research. They are trained to visually detect behavior change over time with a small number of subjects, and they do not rely on averaged results in a group design with large subject numbers. Although mainstream clinical research often uses group designs, single-subject designs have become increasingly popular as flexible and viable alternatives to group designs. These give researchers important feedback at the stage of designing and piloting an intervention for implementing behavioral measurement at a lower cost and time expenditure (Sexton-Radek, 2014; Smith, 2012). However, if behavior analysts demonstrate the effect of their intervention in the context of a group design, communication, acceptability, and dissemination with other clinical scientists, stakeholders, and the public would improve by having a common ground for the language and understanding of efficacy and effectiveness (Winett et al., 1991). If a behavior analyst has never conducted a group design to treat clinical populations before, the analyst should join a research team that specializes in a certain approach and population to evaluate the intensity and integrity of the research activities.

Mothers at risk for adverse health outcomes for themselves and their offspring do not always have stable housing (Washio, Mericle, Cassey, Daubert, & Kirby, 2016), and mothers may be busy with multiple appointments and commitments that affect adherence to an intervention (Cunningham et al., 2017). It is important to identify a setting in the community that has enough patient flow for recruitment and is supportive of the intervention research. Women who are pregnant frequently visit obstetrics and gynecology clinics, and postpartum populations often benefit from community-based services, including special supplemental nutrition programs for Women, Infants, and Children (WIC) and state-funded home visitation programs. Each clinic and program has its own priorities and culture; therefore, it is imperative to build rapport with providers and staff members to conduct recruitment. If the intervention purpose aligns with the clinic or program priorities, the staff and providers may help identify a candidate patient and may recruit a patient for the intervention. If the clinic or program priorities are aligned with the intervention purpose, the clinic or program will typically already screen patients based on these priorities. Staff members frequently like to help with recruitment because they feel that they now have someone to refer patients to; therefore, the intervention research also helps staff members as well.

It is important to always incorporate feedback from providers and patients during the study implementation. The principal investigator should be initially involved in every step of the research implementation process so that all problems are identified and solved. After this initial adjustment period, a research team should be formed so that unbiased staff can independently carry out the intervention. Holding weekly staff meetings to keep track of recruitment, intervention delivery, and retention data is recommended. Because research participation is completely voluntary, reinforcing research participation is also recommended. Offering monetary compensation for

session attendance and periodic assessments can achieve this goal. This compensation should also be extended to the control group that does not receive incentives as the independent variable. This ensures that research participation itself will be reinforced and that a good retention rate (above 80%) will be maintained (Higgins et al., 2008, 2012; Washio, Humphreys, et al., 2017).

Conclusion

This article delineates behavioral health priorities as risk factors for adverse maternal, pregnancy, and birth or infant outcomes. It also addresses the importance and challenges of using behavior analysis to change maternal behavior. We argue that if we successfully address social validity concerns, developing an effective behavior–analytic intervention to address these priorities aligns with the goals of behavior analysis by providing significant health and economic benefits to both mothers and infants. The specific variables to consider to maintain the effect of a behavior–analytic intervention and to address social validity concerns with changing maternal behaviors in a sustainable manner have been described. Future research topics on behavioral prevention for adverse maternal, pregnancy, birth, and infant outcomes should focus on implementing and disseminating effective behavioral interventions in prenatal smoking cessation, developing effective behavioral interventions for addressing postpartum smoking relapse prevention, establishing efficacy and effectiveness in addressing prenatal alcohol use issues, developing behavioral interventions to address maternal obesity and improve birth outcomes, and establishing efficacy and effectiveness in increasing breastfeeding rates. Establishing parameters of control variables and measuring social validity for an effective, sustainable behavior–analytic intervention are critical to pursuing these research topics. We argue that the maternal behavioral health field is a fertile field to apply a realistic behavior–analytic intervention and, with careful consideration, to sustainably affect the world through behavior analysis and behavior science.

Compliance with Ethical Standards

Financial Disclosure The authors have no financial relationships relevant to this article to disclose.

Conflict of Interest The authors have no conflicts of interest to disclose.

References

- Adams, E. K., Miller, V. P., Ernst, C., Nishimura, B. K., Melvin, C., & Merritt, R. (2002). Neonatal health care costs related to smoking during pregnancy. *Health Economics, 11*, 193–206. <https://doi.org/10.1002/hec.660>.
- Alessi, S. M., & Petry, N. M. (2013). A randomized study of cellphone technology to reinforce alcohol abstinence in the natural environment. *Addiction, 108*, 900–909. <https://doi.org/10.1111/add.12093>.
- Aliyu, M. H., Wilson, R. E., Zoorob, R., Chakrabarty, S., Alio, A. P., Kirby, R. S., & Salihi, H. M. (2008). Alcohol consumption during pregnancy and the risk of early stillbirth among singletons. *Alcohol, 42*, 369–374. <https://doi.org/10.1016/j.alcohol.2008.04.003>.

- Allen, S. S., Allen, A. M., Lunos, S., & Tosun, N. (2016). Progesterone and postpartum smoking relapse: A pilot double-blind placebo-controlled randomized trial. *Nicotine & Tobacco Research, 18*, 2145–2153. <https://doi.org/10.1093/ntr/ntw156>.
- Amass, L., & Kamien, J. (2004). A tale of two cities: Financing two voucher programs for substance abusers through community donations. *Experimental and Clinical Psychopharmacology, 12*, 147–155. <https://doi.org/10.1037/1064-1297.12.2.147>.
- American Academy of Pediatrics (AAP). (2012). AAP reaffirms breastfeeding guidelines. Retrieved from <https://www.aap.org/en-us/about-the-aap/aap-press-room/pages/aap-reaffirms-breastfeeding-guidelines.aspx>.
- American Academy of Pediatrics (AAP). (2015). Fetal alcohol spectrum disorders. Retrieved from <http://pediatrics.aappublications.org/content/early/2015/10/13/peds.2015-3113>.
- Bailey, B. A., McCook, J. G., Hodge, A., & McGrady, L. (2012). Infant birth outcomes among substance using women: Why quitting smoking during pregnancy is just as important as quitting illicit drug use. *Maternal and Child Health Journal, 16*, 414–422. <https://doi.org/10.1007/s10995-011-0776-y>.
- Barnett, N. P., Tidey, J., Murphy, J. G., Swift, R., & Colby, S. M. (2011). Contingency management for alcohol use reduction: A pilot study using a transdermal alcohol sensor. *Drug and Alcohol Dependence, 118*(2–3), 391–399. <https://doi.org/10.1016/j.drugalcdep.2011.04.023>.
- Bartick, M. (2011). Breastfeeding and the U. S. economy. *Breastfeeding Medicine, 6*, 313–318. <https://doi.org/10.1089/bfm.2011.0057>.
- Bartick, M. C., Schwarz, E. B., Green, B. D., Jegier, B. J., Reinhold, A. G., Colaizy, T. T., Bogen, D. L., Schaefer, A. J., & Stuebe, A. M. (2017). Suboptimal breastfeeding in the United States: maternal and pediatric health outcomes and costs. *Maternal and Child Nutrition, 13*, 13. <https://doi.org/10.1111/mcn.12366>.
- Beral, V., Bull, D., Doll, R., Peto, R., & Reeves, G. (2002). Breast cancer and breastfeeding: Collaborative reanalysis of individual data from 47 epidemiological studies in 30 countries, including 50,302 women with breast cancer and 96,973 women without the disease. *The Lancet, 360*, 187–195. [https://doi.org/10.1016/S0140-6736\(02\)09454-0](https://doi.org/10.1016/S0140-6736(02)09454-0).
- Boone-Heinonen, J., Messer, L., Andrade, K., & Takemoto, E. (2016). Connecting the dots in childhood obesity disparities: A review of growth patterns from birth to pre-adolescence. *Current Epidemiology Reports, 3*, 113–124. <https://doi.org/10.1007/s40471-016-0065-9>.
- Brownell, M. D., Chartier, M. J., Nickel, N. C., Chateau, D., Martens, P. J., Sarkar, J., . . . , Katz, A. (2016). Unconditional prenatal income supplement and birth outcomes. *Pediatrics, 137*, e20152992. <https://doi.org/10.1542/peds.2015-2992>.
- Cahill, K., Hartmann-Boyce, J., & Perera, R. (2015). Incentives for smoking cessation. *Cochrane Database of Systematic Reviews, 2015*(5). <https://doi.org/10.1002/14651858.CD004307.pub5>.
- Catalano, P. M., & Shankar, K. (2017). Obesity and pregnancy: Mechanisms of short term and long term adverse consequences for mother and child. *BMJ, 356*, j1. <https://doi.org/10.1136/bmj.j1>.
- Centers for Disease Control and Prevention. (2015). Vital signs: Disparities in nonsmokers' exposure to secondhand smoke—United States, 1999–2012. Retrieved from https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6404a7.htm?s_cid=mm6404a7_w.
- Chamberlain, C., O'Mara-Eves, A., Oliver, S., Caird, J. R., Perlen, S. M., Eades, S. J., & Thomas, J. (2017). Psychosocial interventions for supporting women to stop smoking in pregnancy. *Cochrane Database of Systematic Reviews, 2017*(2). <https://doi.org/10.1002/14651858.CD001055.pub5>.
- Chapman, D. J., & Pérez-Escamilla, R. (2012). Breastfeeding among minority women: Moving from risk factors to interventions. *Advances in Nutrition, 3*, 95–104. <https://doi.org/10.3945/an.111.001016>.
- Chowdhury, R., Sinha, B., Sankar, M. J., Taneja, S., Bhandari, N., Rollins, N., Bahl, R., & Martinez, J. (2015). Breastfeeding and maternal health outcomes: A systematic review and meta-analysis. *Acta Paediatrica, 104*, 96–113. <https://doi.org/10.1111/apa.13102>.
- Coleman, T., Chamberlain, C., Davey, M.-A., Cooper, S. E., & Leonardi-Bee, J. (2015). Pharmacological interventions for promoting smoking cessation during pregnancy. *Cochrane Database of Systematic Reviews, 2015*(12). <https://doi.org/10.1002/14651858.CD010078.pub2>.
- Cooper, W., Heron, J. O., & Heward, T. E. (Eds.). (2007). *Applied behavior analysis (2nd Ed.)*. Upper Saddle River, NJ: Pearson.
- Cunningham, S. D., Grilo, S., Lewis, J. B., Novick, G., Rising, S. S., Tobin, J. N., & Ickovics, J. R. (2017). Group prenatal care attendance: Determinants and relationship with care satisfaction. *Maternal and Child Health Journal, 21*, 770–776. <https://doi.org/10.1007/s10995-016-2161-3>.
- Dewey, K. G., Heinig, M. J., & Nommsen, L. A. (1993). Maternal weight-loss patterns during prolonged lactation. *The American Journal of Clinical Nutrition, 58*, 162–166.

- Donatelle, R., Hudson, D., Dobie, S., Goodall, A., Hunsberger, M., & Oswald, K. (2004). Incentives in smoking cessation: Status of the field and implications for research and practice with pregnant smokers. *Nicotine & Tobacco Research*, 6, 163–179. <https://doi.org/10.1080/1462200410001669196>.
- Dupraz, J., Graff, V., Barasche, J., Etter, J. F., & Boulvain, M. (2013). Tobacco and alcohol during pregnancy: Prevalence and determinants in Geneva in 2008. *Swiss Medical Weekly*, 143. <https://doi.org/10.4414/smw.2013.13795>.
- Ernst, C. C., Grant, T. M., Streissguth, A. P., & Sampson, P. D. (1999). Intervention with high-risk alcohol and drug-abusing mothers: II. Three-year findings from the Seattle model of paraprofessional advocacy. *Journal of Community Psychology*, 27, 19–38. [https://doi.org/10.1002/\(SICI\)1520-6629\(199901\)27:1<19::AID-JCOP2>3.0.CO;2-K](https://doi.org/10.1002/(SICI)1520-6629(199901)27:1<19::AID-JCOP2>3.0.CO;2-K).
- Feeney, A., & Britton, G. (2016). Counseling women on smoking relapse prevention during postpartum. *MCN: The American Journal of Maternal/Child Nursing*, 41, 287–292. <https://doi.org/10.1097/NMC.0000000000000262>.
- Florence, C. S., Adams, E. K., & Ayadi, M. F. (2007). Pediatric health care costs attributable to exposure to second-hand smoke: An exploratory analysis. *Journal of Health Care Finance*, 34, 36–43.
- Furman, L. (2017). Should we pay mothers who receive WIC to breastfeed? *Pediatrics*, 139, e20163828. <https://doi.org/10.1542/peds.2016-3828>.
- Gamble, C., & Hart, C. (2003). The use of psychosocial interventions. *Nursing Times*, 99, 46–47.
- Gardiner, C. K., & Bryan, A. D. (2017). Monetary incentive interventions can enhance psychological factors related to fruit and vegetable consumption. *Annals of Behavioral Medicine*, 51, 599–609. <https://doi.org/10.1007/s12160-017-9882-4>.
- Grant, T., Ernst, C. C., Pagalilauan, G., & Streissguth, A. (2003). Postprogram follow-up effects of paraprofessional intervention with high-risk women who abused alcohol and drugs during pregnancy. *Journal of Community Psychology*, 31, 211–222. <https://doi.org/10.1002/jcop.10048>.
- Hartzler, B., Lash, S. J., & Roll, J. M. (2012). Contingency management in substance abuse treatment: a structured review of the evidence for its transportability. *Drug and Alcohol Dependence*, 122, 1–2, 1–10. <https://doi.org/10.1016/j.drugalcdep.2011.11.011>.
- Heil, S. H., Hand, D. J., Sigmon, S. C., Badger, G. J., Meyer, M. C., & Higgins, S. T. (2016). Using behavioral economic theory to increase use of effective contraceptives among opioid-maintained women at risk of unintended pregnancy. *Preventive Medicine*, 92, 62–67. <https://doi.org/10.1016/j.ypmed.2016.06.023>.
- Higgins, S. T., Bickel, W. K., & Hughes, J. R. (1994). Influence of an alternative reinforcer on human cocaine self-administration. *Life Sciences*, 55, 179–187.
- Higgins, S. T., Budney, A. J., Bickel, W. K., Hughes, J. R., Foerg, F., & Badger, G. (1993). Achieving cocaine abstinence with a behavioral approach. *The American Journal of Psychiatry*, 150, 763–769.
- Higgins, S. T., & Petry, N. M. (1999). Contingency management. Incentives for sobriety. *Alcohol Research & Health*, 23, 122–127.
- Higgins, S. T., Silverman, K., & Heil, S. H. (Eds.). (2008). *Contingency management in substance abuse treatment*. New York, NY: Guilford Press.
- Higgins, S. T., Washio, Y., Heil, S. H., Solomon, L. J., Gaalema, D. E., Higgins, T. M., & Bernstein, I. M. (2012). Financial incentives for smoking cessation among pregnant and newly postpartum women. *Preventive Medicine*, 55, S33–S40. <https://doi.org/10.1016/j.ypmed.2011.12.016>.
- Howell, E. A., Bodnar-Deren, S., Balbierz, A., Parides, M., & Bickell, N. (2014). An intervention to extend breastfeeding among black and Latina mothers after delivery. *American Journal of Obstetrics and Gynecology*, 210, 239.e1–239.e5. <https://doi.org/10.1016/j.ajog.2013.11.028>.
- Ip, S., Chung, M., Raman, G., Chew, P., Magula, N., Devine, D., . . . Lau, J. (2007). *Breastfeeding and maternal and infant health outcomes in developed countries* (AHRQ Publication No. 07-E007). Retrieved from Agency for Healthcare Research and Quality (AHRQ) website: <https://archive.ahrq.gov/downloads/pub/evidence/pdf/brfout/brfout.pdf>.
- Jaacks, L. M., Kavle, J., Perry, A., & Nyaku, A. (2017). Programming maternal and child overweight and obesity in the context of undernutrition: current evidence and key considerations for low- and middle-income countries. *Public Health Nutrition*, 20, 1286–1296. <https://doi.org/10.1017/S13688980016003323>.
- Janisse, J. J., Bailey, B. A., Ager, J., & Sokol, R. J. (2014). Alcohol, tobacco, cocaine, and marijuana use: Relative contributions to preterm delivery and fetal growth restriction. *Substance Abuse*, 35, 60–67. <https://doi.org/10.1080/08897077.2013.804483>.
- Kamboj, A. K., & Krishna, S. G. (2017). Pokémon GO: An innovative smartphone gaming application with health benefits. *Primary Care Diabetes*, 11, 397–399. <https://doi.org/10.1016/j.pcd.2017.03.008>.
- Kelley, D. P., & Wine, B. (2016). A review of *Consumer Behavior Analysis: (A) Rational Approach to Consumer Choice* by David P. Kelley III and Byron Wine. *Journal of Organizational Behavior Management*, 36, 94–97. <https://doi.org/10.1080/01608061.2015.1093054>.

- Kerwin, M. E., Farris, M. D., & Hantula, D. A. (2012). Consumer choices of women in residential drug treatment: An analysis of risk and impulsivity. *Journal of Applied Social Psychology, 42*, 834–849. <https://doi.org/10.1111/j.1559-1816.2011.00830.x>.
- Klein, E. P. (2014). Patient health incentives: Ethical challenges and frameworks. *International Journal of Behavioral Medicine, 21*, 995–1004. <https://doi.org/10.1007/s12529-013-9373-3>.
- Kurti, A. N., & Dallery, J. (2013). Internet-based contingency management increases walking in sedentary adults. *Journal of Applied Behavior Analysis, 46*, 568–581. <https://doi.org/10.1002/jaba.58>.
- Langer, A., Meleis, A., Knaul, F. M., Atun, R., Aran, M., Arreola-Ornelas, H., . . . Frenk, J. (2015). Women and health: The key for sustainable development. *The Lancet, 386*, 1165–1210. [https://doi.org/10.1016/S0140-6736\(15\)60497-4](https://doi.org/10.1016/S0140-6736(15)60497-4).
- Logan, C. A., Rothenbacher, D., & Genuneit, J. (2017). Postpartum smoking relapse and breast feeding: Defining the window of opportunity for intervention. *Nicotine & Tobacco Research, 19*, 367–372. <https://doi.org/10.1093/ntr/ntw224>.
- Lui, S., Terplan, M., & Smith, E. J. (2008). Psychosocial interventions for women enrolled in alcohol treatment during pregnancy. *Cochrane Database of Systematic Reviews, 2008*(3). <https://doi.org/10.1002/14651858.CD006753.pub2>.
- Lussier, J. P., Heil, S. H., Mongeon, J. A., Badger, G. J., & Higgins, S. T. (2006). A meta-analysis of voucher-based reinforcement therapy for substance use disorders. *Addiction, 101*, 192–203. <https://doi.org/10.1111/j.1360-0443.2006.01311.x>.
- Magro-Malosso, E. R., Saccone, G., Di Mascio, D., Di Tommaso, M., & Berghella, V. (2017). Exercise during pregnancy and risk of preterm birth in overweight and obese women: A systematic review and meta-analysis of randomized controlled trials. *Acta Obstetrica et Gynecologica Scandinavica, 96*, 263–273. <https://doi.org/10.1111/aogs.13087>.
- Max, W., Sung, H.-Y., & Shi, Y. (2015). The cost of secondhand smoke exposure at home in California. *Tobacco Control, 24*, 205–210. <https://doi.org/10.1136/tobaccocontrol-2013-051253>.
- May, P. A., Hasken, J. M., Blankenship, J., Marais, A.-S., Joubert, B., Cloete, M., . . . Seedat, S. (2016). Breastfeeding and maternal alcohol use: Prevalence and effects on child outcomes and fetal alcohol spectrum disorders. *Reproductive Toxicology, 63*, 13–21. <https://doi.org/10.1016/j.reprotox.2016.05.002>.
- Meredith, S., Jarvis, B., Raiff, B., Rojewski, A., Cassidy, R., Erb, P., . . . Kurti, A. (2014). The ABCs of incentive-based treatment in health care: A behavior analytic framework to inform research and practice. *Psychology Research and Behavior Management, 7*, 103–114. <https://doi.org/10.2147/PRBM.S59792>.
- Meredith, S. E., Grabinski, M. J., & Dallery, J. (2011). Internet-based group contingency management to promote abstinence from cigarette smoking: A feasibility study. *Drug and Alcohol Dependence, 118*, 23–30. <https://doi.org/10.1016/j.drugalcdep.2011.02.012>.
- Miller, W. R., Meyers, R. J., & Hiller-Sturmhöfel, S. (1999). The community-reinforcement approach. *Alcohol Research & Health, 23*, 116–121.
- Moran, V. H., Morgan, H., Rothnie, K., MacLennan, G., Stewart, F., Thomson, G., . . . Hoddinott, P. (2015). Incentives to promote breastfeeding: A systematic review. *Pediatrics, 135*, e687–e702. <https://doi.org/10.1542/peds.2014-2221>.
- Morgan, L., Stanton, M. E., Higgs, E. S., Balster, R. L., Bellows, B. W., Brandes, N., . . . Koblinsky, M. (2013). Financial incentives and maternal health: Where do we go from here? *Journal of Health, Population, and Nutrition, 31*(4 Suppl. 2), 8–22.
- National Institute for Health and Care Excellence (NICE). (2010). NICE Citizens Council meeting: the use of incentives to improve health. Retrieved from https://www.ncbi.nlm.nih.gov/pubmedhealth/PMH0091203/pdf/PubMedHealth_PMH0091203.pdf.
- NEOVITA Study Group. (2016). Timing of initiation, patterns of breastfeeding, and infant survival: Prospective analysis of pooled data from three randomised trials. *The Lancet Global Health, 4*, e266–e275. [https://doi.org/10.1016/S2214-109X\(16\)00040-1](https://doi.org/10.1016/S2214-109X(16)00040-1).
- Olds, D. L., Kitzman, H., Knudtson, M. D., Anson, E., Smith, J. A., & Cole, R. (2014). Effect of home visiting by nurses on maternal and child mortality. *JAMA Pediatrics, 168*, 800–806. <https://doi.org/10.1001/jamapediatrics.2014.472>.
- Patnode, C. D., Henderson, J. T., Thompson, J. H., Senger, C. A., Fortmann, S. P., & Whitlock, E. P. (2015). Behavioral counseling and pharmacotherapy interventions for tobacco cessation in adults, including pregnant women: A review of reviews for the U.S. Preventive Services Task Force. *Annals of Internal Medicine, 163*, 608–621. <https://doi.org/10.7326/M15-0171>.
- Paul-Ebhohimhen, V., & Avenell, A. (2008). Systematic review of the use of financial incentives in treatments for obesity and overweight. *Obesity Reviews, 9*, 355–367. <https://doi.org/10.1111/j.1467-789X.2007.00409.x>.

- Paxton, R. (1983). Prolonging the effects of deposit contracts with smokers. *Behavior Research and Therapy*, 21, 425–433.
- Petry, N. M., Alessi, S. M., & Ledgerwood, D. M. (2012). A randomized trial of contingency management delivered by community therapists. *Journal of Consulting and Clinical Psychology*, 80, 286–298. <https://doi.org/10.1037/a0026826>.
- Pettifor, A., MacPhail, C., Nguyen, N., & Rosenberg, M. (2012). Can money prevent the spread of HIV? A review of cash payments for HIV prevention. *AIDS and Behavior*, 16, 1729–1738. <https://doi.org/10.1007/s10461-012-0240-z>.
- Philipp, B. L., Merewood, A., Miller, L. W., Chawla, N., Murphy-Smith, M. M., Gomes, J. S., . . . Cook, J. T. (2001). Baby-friendly hospital initiative improves breastfeeding initiation rates in a US hospital setting. *Pediatrics*, 108, 677–681.
- Pollak, K. I., Fish, L. J., Lyna, P., Peterson, B. L., Myers, E. R., Gao, X., . . . Pletsch, P. K. (2016). Efficacy of a nurse-delivered intervention to prevent and delay postpartum return to smoking: the quit for two trial. *Nicotine & Tobacco Research*, 18, 1960–1966. <https://doi.org/10.1093/ntr/ntw108>.
- Popova, S., Lange, S., Burd, L., Chudley, A. E., Clarren, S. K., & Rehm, J. (2013). Cost of fetal alcohol spectrum disorder diagnosis in Canada. *PLoS One*, 8, e60434. <https://doi.org/10.1371/journal.pone.0060434>.
- Popova, S., Lange, S., Burd, L., & Rehm, J. (2012). Health care burden and cost associated with fetal alcohol syndrome: Based on official Canadian data. *PLoS One*, 7, e43024. <https://doi.org/10.1371/journal.pone.0043024>.
- Raftery, J., Kerr, C., Hawker, S., & Powell, J. (2009). Paying clinicians to join clinical trials: A review of guidelines and interview study of trialists. *Trials*, 10. <https://doi.org/10.1186/1745-6215-10-15>.
- Rahman, M. M., Abe, S. K., Rahman, M. S., Kanda, M., Narita, S., Bilano, V., . . . Shibuya, K. (2016). Maternal anemia and risk of adverse birth and health outcomes in low- and middle-income countries: Systematic review and meta-analysis. *American Journal of Clinical Nutrition*, 103, 495–504. <https://doi.org/10.3945/ajcn.115.107896>.
- Rasmussen, C., Kully-Martens, K., Denys, K., Badry, D., Henneveld, D., Wyper, K., & Grant, T. (2012). The effectiveness of a community-based intervention program for women at-risk for giving birth to a child with fetal alcohol spectrum disorder (FASD). *Community Mental Health Journal*, 48, 12–21. <https://doi.org/10.1007/s10597-010-9342-0>.
- Rimer, B. K., Glanz, K., & Rasband, G. (2001). Searching for evidence about health education and health behavior interventions. *Health Education & Behavior*, 28, 231–248. <https://doi.org/10.1177/109019810102800208>.
- Risica, P. M., Gavarkovs, A., Parker, D. R., Jennings, E., & Phipps, M. (2017). A tailored video intervention to reduce smoking and environmental tobacco exposure during and after pregnancy: Rationale, design and methods of Baby's breath. *Contemporary Clinical Trials*, 52, 1–9. <https://doi.org/10.1016/j.cct.2016.10.010>.
- Rocca, P. V. (2017). A sad state of affairs. *Delaware Medical Journal*, 89, 20.
- Rosenblatt, K. A., & Thomas, D. B. (1993). Lactation and the risk of epithelial ovarian cancer. The WHO Collaborative Study of Neoplasia and Steroid Contraceptives. *International Journal of Epidemiology*, 22, 192–197.
- Schottenfeld, R. S., Moore, B., & Pantalon, M. V. (2011). Contingency management with community reinforcement approach or twelve-step facilitation drug counseling for cocaine dependent pregnant women or women with young children. *Drug and Alcohol Dependence*, 118, 48–55. <https://doi.org/10.1016/j.drugalcdep.2011.02.019>.
- Sexton-Radek, K. (2014). Single case designs in psychology practice. *Health Psychology Research*, 2. <https://doi.org/10.4081/hpr.2014.1551>.
- Sinigaglia, O. E., Ríos, E. M., Campos, M., Díaz, B., & Palacios, C. (2016). Breastfeeding practices, timing of introduction of complementary beverages and foods and weight status in infants and toddlers participants of a WIC clinic in Puerto Rico. *SpringerPlus*, 5, 1437. <https://doi.org/10.1186/s40064-016-3154-9>.
- Smith, E. J., Lui, S., & Terplan, M. (2009). Pharmacologic interventions for pregnant women enrolled in alcohol treatment. *Cochrane Database of Systematic Reviews*, 2009(3). <https://doi.org/10.1002/14651858.CD007361.pub2>.
- Smith, J. D. (2012). Single-case experimental designs: A systematic review of published research and current standards. *Psychological Methods*, 17, 510–550. <https://doi.org/10.1037/a0029312>.
- Smithers, L. G., Kramer, M. S., & Lynch, J. W. (2015). Effects of breastfeeding on obesity and intelligence: Causal insights from different study designs. *JAMA Pediatrics*, 169, 707–708. <https://doi.org/10.1001/jamapediatrics.2015.0175>.

- Stade, B. C., Bailey, C., Dzenoletas, D., Sgro, M., Dowswell, T., & Bennett, D. (2009). Psychological and/or educational interventions for reducing alcohol consumption in pregnant women and women planning pregnancy. *Cochrane Database of Systematic Reviews*, 2009(2). <https://doi.org/10.1002/14651858.CD004228.pub2>.
- Stanton, M. E., Higgs, E. S., & Koblinsky, M. (2013). Investigating financial incentives for maternal health: An introduction. *Journal of Health, Population, and Nutrition*, 31(4 Suppl. 2), 1–7.
- Substance Abuse and Mental Health Services Administration (SAMHSA). (2015). Results from the 2015 National Survey on Drug Use and Health: Detailed tables. Retrieved from <https://www.samhsa.gov/data/sites/default/files/NSDUH-DefTabs-2015/NSDUH-DefTabs-2015/NSDUH-DefTabs-2015.htm#tab6-72b>.
- Tay, R. Y., Wilson, J., McCormack, C., Allsop, S., Najman, J. M., Burns, L., . . . Hutchinson, D. (2017). Alcohol consumption by breastfeeding mothers: frequency, correlates and infant outcomes. *Drug and Alcohol Review*, 36, 667–676. <https://doi.org/10.1111/dar.12473>.
- Till, S. R., Everetts, D., & Haas, D. M. (2015). Incentives for increasing prenatal care use by women in order to improve maternal and neonatal outcomes. *Cochrane Database of Systematic Reviews*, 2015(12). <https://doi.org/10.1002/14651858.CD009916.pub2>.
- Treyster, Z., & Gitterman, B. (2011). Second hand smoke exposure in children: Environmental factors, physiological effects, and interventions within pediatrics. *Reviews on Environmental Health*, 26, 187–195.
- U.S. Department of Health and Human Services. (2011). Executive summary: The surgeon general’s call to action to support breastfeeding. Retrieved from <http://www.surgeongeneral.gov/library/calls/breastfeeding/executivesummary.pdf>.
- Volpp, K. G., John, L. K., Troxel, A. B., Norton, L., Fassbender, J., & Loewenstein, G. (2008). Financial incentive-based approaches for weight loss: A randomized trial. *JAMA*, 300, 2631–2637. <https://doi.org/10.1001/jama.2008.804>.
- Washington, W. D., Banna, K. M., & Gibson, A. L. (2014). Preliminary efficacy of prize-based contingency management to increase activity levels in healthy adults. *Journal of Applied Behavior Analysis*, 47, 231–245. <https://doi.org/10.1002/jaba.119>.
- Washio, Y., Archibald, A., Frederick, J., & Crowe, J. A. (2017). Community-based pilot program “My Baby’s Breath” to reduce prenatal alcohol use. *Delaware Medical Journal*, 89, 46–51.
- Washio, Y., Humphreys, M., Colchado, E., Sierra-Ortiz, M., Zhang, Z., Collins, B. N., . . . Kirby, K. C. (2017). Incentive-based intervention to maintain breastfeeding among low-income Puerto Rican mothers. *Pediatrics*, 139, e20163119. <https://doi.org/10.1542/peds.2016-3119>.
- Washio, Y., Mericle, A. A., Cassey, H., Daubert, A. M., & Kirby, K. C. (2016). Characteristics of low-income racial/ethnic minority pregnant women screening positive for alcohol risk. *Journal of Immigrant and Minority Health*, 18, 850–855. <https://doi.org/10.1007/s10903-015-0238-5>.
- Winett, R. A., Moore, J. F., & Anderson, E. S. (1991). Extending the concept of social validity: Behavior analysis for disease prevention and health promotion. *Journal of Applied Behavior Analysis*, 24, 215–230. <https://doi.org/10.1901/jaba.1991.24-215>.
- Witter, S., Fretheim, A., Kessy, F. L., & Lindahl, A. K. (2012). Paying for performance to improve the delivery of health interventions in low- and middle-income countries. *Cochrane Database of Systematic Reviews*, 2012(2). <https://doi.org/10.1002/14651858.CD007899.pub2>.
- Working Group on Incentives for Living Donation. (2012). Incentives for organ donation: Proposed standards for an internationally acceptable system. *American Journal of Transplantation*, 12, 306–312. <https://doi.org/10.1111/j.1600-6143.2011.03881.x>.
- World Health Organization NCD Alliance. (2011). Non-communicable diseases: A priority for women’s health and development. Retrieved from http://www.who.int/pmnch/topics/maternal/2011_women_ncd_report.pdf.pdf.
- Yeo, S., Walker, J. S., Caughey, M. C., Ferraro, A. M., & Asafu-Adjei, J. K. (2017). What characteristics of nutrition and physical activity interventions are key to effectively reducing weight gain in obese or overweight pregnant women? A systematic review and meta-analysis. *Obesity Reviews*, 18, 385–399. <https://doi.org/10.1111/obr.12511>.