Evaluating the Use of Lottery-Based Contingency Management to Increase Physical Activity in Adults

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Evaluating the Use of Lottery-Based Contingency Management to Increase Physical Activity in Adults

Jennifer M. Owsiany, M.S.

Dissertation submitted to the Eberly College of Arts and Sciences at West Virginia University in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Psychology

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Morgantown, West Virginia 2019

Keywords: adults, caloric expenditure, contingency management, financial incentives, physical activity
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Abstract

Evaluating the Use of Lottery-Based Contingency Management to Increase Physical Activity in Adults

Jennifer M. Owsiany

It is widely known that physically inactive adults are at a greater risk for developing noncommunicable diseases (e.g., cancer, stroke, coronary heart disease, type 2 diabetes) and premature death compared to their physically active peers. Consequently, physical inactivity is one of the leading causes of death worldwide. Thus, it is important to develop effective ways to increase and maintain physical activity. In the current study, we randomly assigned adults between the ages of 18 and 64 years old to one of three groups (i.e., contingency management, participation-based incentive, and self-monitoring). Participants wore Fitbit Alta HR fitness tracking devices, which provided data on various indicators of daily physical activity, like calorie expenditure, steps taken, active min, etc. The experimenters also collected data on physiological indicators of physical activity, such as resting heart rate and weight. The results of the current study suggest that contingency management was not any more effective at increasing physical activity (as measured by average daily calorie expenditure) compared to participation-based incentives and self-monitoring. However, the majority of participants in the study were White females, and race/ethnicity was not equally distributed across groups. These disparities in demographic information and other limitations to the study and how they impacted the results will be discussed. Based on previous physical activity research and the results of the current study, the best ways to increase physical activity for adults remain unclear. Researchers should continue to investigate intervention techniques to increase physical activity for adults.
# Table of Contents

Introduction ................................................................................................................................. 1  
Benefits of Physical Activity ........................................................................................................ 2  
Costs of Being Physically Inactive .............................................................................................. 3  
Ways to Increase Physical Activity ............................................................................................. 4  
  Behavioral Intervention Packages .............................................................................................. 4  
  Financial Incentives .................................................................................................................. 6  
  Contingency Management ......................................................................................................... 8  
Purpose ........................................................................................................................................ 10  

Method ....................................................................................................................................... 11  
Participants .................................................................................................................................. 11  
  Recruitment .............................................................................................................................. 13  
  Informed Consent and Screening ............................................................................................... 13  
    Inclusion Criteria ................................................................................................................... 14  
    Study Termination Criteria ..................................................................................................... 15  
Materials ..................................................................................................................................... 15  
Dependent Measures and Data Collection ................................................................................... 16  
Interobserver Agreement and Treatment Integrity ....................................................................... 17  
Experimental Design .................................................................................................................. 18  
Procedures ................................................................................................................................... 18  
  Weight, Blood Pressure, and Heart Rate Monitoring ................................................................ 18  
  Baseline .................................................................................................................................... 19  
  Fitbit Setup ................................................................................................................................ 19  
  Contingency Management (CM) Group ...................................................................................... 20  
    Goal Setting ............................................................................................................................. 20  
    Reinforcement .......................................................................................................................... 21  
  Participation-Based Incentive (PBI) Group ............................................................................... 22  
  Self-Monitoring (SM) Group ...................................................................................................... 22  
Data Analysis ............................................................................................................................... 22  

Results ....................................................................................................................................... 23  
  Primary Dependent Measure – Calorie Expenditure ................................................................ 23  
  Secondary Dependent Measures ............................................................................................... 28  
  Steps ......................................................................................................................................... 28  
  Active Min ................................................................................................................................. 29  
  Time Spent in Each Activity Zone ............................................................................................. 30  
  Resting Heart Rate ................................................................................................................... 33  
  Weight ...................................................................................................................................... 34  

Discussion ................................................................................................................................... 36  
  Demographic Information ......................................................................................................... 38  
  Dependent Variables and Data Collection ................................................................................ 39  
  Duration of Interventions and Maintenance .............................................................................. 42  
  Strengths and Limitations ......................................................................................................... 43
Table 1: Demographic information for the participants in the CM, PBI, and SM groups……59

Table 2: Descriptive statistics for the average number of calories expended per day, the average number of steps taken per day, and the average number of active min per day for the CM, PBI, and SM groups .................................................................60

Table 3: The average percent change in the average number of calories expended per day, the average number of steps taken per day, average resting heart rate, and average weight between baseline and intervention for the CM, PBI, and SM groups ..........................61

Table 4: The average percent of days where participants in the CM group expended a greater number of calories per day during intervention compared to the average number of calories expended per day during the entire baseline phase ........................................62

Table 5: The average percent of days where participants in the CM group expended a greater number of calories per day during intervention compared to the average number of calories expended per day for the last six days of the baseline phase .....................63

Table 6: Average differences in the average number of active min per day and the average number of min spent in the Fat Burn, Cardio, and Peak activity zones for the CM, PBI, and SM groups .................................................................64

Table 7: Descriptive statistics for the average number of min spent in the Fat Burn, Cardio, and Peak activity zones for the CM, PBI, and SM groups .................................................................65

Table 8: Descriptive statistics for average resting heart rate at the start of the study, following the baseline phase, and post-intervention for the CM, PBI, and SM groups .............66

Table 9: Descriptive statistics for average weight at the start of the study, following the baseline phase, and post-intervention for the CM, PBI, and SM groups .................................67

Table 10: The average percent of days during intervention on which participants in the CM group met their calorie-expenditure goals and the number of gift cards they earned...68
INCREASING PHYSICAL ACTIVITY

List of Figures

Figure 1: Means and standard errors for the average number of calories expended per day in baseline and intervention .................................................................69

Figure 2: Average percent change in the average number of calories expended per day between baseline and intervention .................................................................70

Figure 3: Average percent of days in intervention where the number of calories expended per day was greater than the total baseline average for participants in the CM group ....71

Figure 4: Average percent of days in intervention where the number of calories expended per day was greater than the average from the last six days of baseline for participants in the CM group .................................................................72

Figure 5: Results from the time series analysis and time series forecast for all groups ....73

Figure 6: Means and standard errors for the average number of steps taken per day in baseline and intervention .................................................................74

Figure 7: Average percent change in the average number of steps taken per day between baseline and intervention .................................................................75

Figure 8: Means and standard errors for the average active min per day in baseline and intervention .................................................................76

Figure 9: Average difference in average active min per day between baseline and intervention.77

Figure 10: Means and standard errors for the average time spent (in min) in the Fat Burn zone in baseline and intervention .................................................................78

Figure 11: Means and standard errors for the average time spent (in min) in the Cardio zone in baseline and intervention .................................................................79

Figure 12: Means and standard errors for the average time spent (in min) in the Peak zone in baseline and intervention .................................................................80

Figure 13: Average difference in average time spent (in min) in each activity zone between baseline and intervention .................................................................81

Figure 14: Average percent change in average resting heart rate between baseline and intervention .................................................................82

Figure 15: Average percent change in average weight between baseline and intervention ....83

Figure 16: Correlation between goals met and gift cards earned for CM group ..........84
### List of Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANCOVA</td>
<td>Analysis of covariance</td>
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<tr>
<td>ANOVA</td>
<td>Analysis of variance</td>
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<tr>
<td>bpm</td>
<td>beats per minute</td>
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<td>CDC</td>
<td>The Centers for Disease Control and Prevention</td>
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<td>CM</td>
<td>Contingency Management</td>
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<tr>
<td>hr</td>
<td>hour(s)</td>
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<tr>
<td>kg</td>
<td>kilogram(s)</td>
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<tr>
<td>min</td>
<td>minute(s)</td>
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<tr>
<td>PBI</td>
<td>Participation-Based Incentive</td>
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<tr>
<td>RMSE</td>
<td>Root Mean Square Error</td>
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<tr>
<td>SD</td>
<td>Standard Deviation</td>
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<tr>
<td>SEM</td>
<td>Standard Error of the Mean</td>
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<tr>
<td>SM</td>
<td>Self-Monitoring</td>
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<tr>
<td>WHO</td>
<td>The World Health Organization</td>
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<td>WVU</td>
<td>West Virginia University</td>
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Evaluating the Use of Lottery-Based Contingency Management to Increase Physical Activity in Adults

Obesity is a serious health issue that, in part, stems from a lack of physical activity and a sedentary lifestyle (Jensen et al., 2013). According to Hales, Carroll, Fryer, and Ogden (2018), as of 2015-2016, approximately 40% of American adults were considered obese (i.e., having a body mass index greater than or equal to 30; Jensen et al., 2013). Obesity can have negative health effects, including, but not limited to death, high blood pressure, type 2 diabetes, stroke, some cancers, and an overall lower quality of life (Jensen et al., 2013).

Organizations like the World Health Organization (WHO; 2018b), the Centers for Disease Control and Prevention (CDC, 2016), and the United States Department of Health and Human Services (Olson et al., 2018) recommend that adults between the ages of 18 and 64 years engage in at least 150 min of physical activity per week. According to the WHO (2018b), approximately 1 in 4 adults between the ages of 18 and 64 years do not meet these recommendations. Furthermore, the Americas are one of the most physically inactive regions in the world, where approximately 50% of women and 40% of men are considered inactive or sedentary (WHO, 2018b). According to Owen, Sparling, Healy, Dunstan, and Matthews (2010), American adults spend approximately 70% of their waking hours engaging in sedentary activities (e.g., sitting, watching television), 30% of their time engaging in light physical activities (e.g., walking), and allocating almost no time for engaging in purposeful physical activity/exercise (e.g., running, strength training). Because physical inactivity can cause obesity and serious illnesses, it is necessary to continue investigating ways to increase physical activity in adults.
Benefits of Physical Activity

A major benefit of engaging in the recommended amount of physical activity is improvements in physical and mental health. Increased physical activity (even an extra 10 min per day) can reduce the risk of premature death and noncommunicable diseases such as coronary heart disease, type 2 diabetes, stroke, and various types of cancer (CDC, 2016; Lee et al., 2012; WHO, 2018a). In addition to reducing the risk of premature death and illness, increased physical activity can lead to increases in balance, bone and muscle health, cardiovascular fitness, energy, and weight control, and decrease the risk for physical injuries (CDC, 2016; WHO, 2018a). In fact, if every inactive adult became active, the average global life span would increase by an average of 0.68 years (Lee et al.). In addition to the numerous physical benefits that adults can experience from engaging in physical activity, they can also experience improvements in their mental health. For instance, individuals may experience amelioration of symptoms of psychological disorders. Specifically, increased engagement in physical activity may reduce symptoms of anxiety and depression (e.g., Sharma, Madaan, & Petty, 2006). Additionally, physically active adults may experience enhancements in mood and cognitive functioning (e.g., Callaghan, 2004), social interactions (e.g., Peluso & Andrade, 2005), and stress (e.g., Sharma et al.). Improvements such as these can increase quality of life.

While it is possible for adults to experience increases in quality of life as a result of engaging in physical activity, their children may experience indirect benefits. Currently, children spend approximately 7.5 hr per day engaging in sedentary activities (e.g., watching TV, playing videogames; Rideout, Foehr, & Roberts, 2010). The CDC (2016) reports that less than 3 of 10 high school students engage in the recommended amount of physical activity for children (i.e., at least one hr a day). The lack of physical activity in which children and adolescents engage is
problematic because they may experience health issues as they grow older. Research suggests that the children of physically active adults tend to be more physically active compared to the children of physically inactive adults (Madsen, McCulloch, & Crawford, 2009; Wright, Wilson, Griffin, & Evans, 2010), which may lead to physical and mental health improvements in children like those experienced by physically active adults. Thus, interventions to increase physical activity in adults may prevent physical-inactivity related health problems that children may experience as they grow older while promoting the general health of their families.

**Costs of Being Physically Inactive**

Physical inactivity is one of the leading causes of preventable death among adults in the United States (WHO, 2018a). Adults who are physically inactive have an increased risk for noncommunicable diseases such as coronary heart disease, type 2 diabetes, cancer, and stroke (WHO, 2018). Lee et al. (2012) estimated that 43% of individuals suffering from type 2 diabetes, premature death, and colon cancer; 42% of individuals with coronary heart disease; and 41% of individuals with breast cancer are also physically inactive. Furthermore, according to Lee and colleagues, physical inactivity is the primary variable responsible for approximately 6-10% of major noncommunicable diseases and 9% of premature deaths. It is clear that physical inactivity is a serious public health issue, as there are many negative health implications, as well as economic implications.

Several studies have analyzed and estimated global and national healthcare costs associated with physical inactivity (e.g., Carlson, Fulton, Pratt, Yang, & Adams, 2015; Chenoweth & Leutzinger, 2006; Ding et al., 2016; Katzmarzyk & Janssen, 2004; Peeters, Mishra, Dobson, & Brown, 2014). Global economic costs associated with physical inactivity averaged $53.8 billion in the year 2013 (Ding et al.). On a national level in the United States,
Chenoweth and Leutzinger analyzed the economic costs of physical inactivity and excess weight in adults from seven states (i.e., CA, TX, MA, NY, NC, and WA). They estimated the national economic cost of physical inactivity to be approximately $251 billion per year. These global and national healthcare costs can be attributed to variables including, but not limited to, worker’s compensation, medical and disability leave, direct medical care (i.e., doctor and hospital visits, pharmaceutical costs), and lack of productivity in the work place (Kruk, 2014; Pratt, Macera, & Wang, 2000). Considering the negative physical health, mental health, and economic implications of physical inactivity, researchers should prioritize investigating interventions to increase physical activity in adults.

Ways to Increase Physical Activity

**Behavioral intervention packages.** Several studies have investigated the utility of behavioral intervention packages for increasing physical activity in adults (e.g., Donaldson & Normand, 2009; Normand, 2008; Wack, Crossland, & Miltenberger, 2014). A behavioral intervention package refers to a group of individual interventions that are implemented together. Donaldson and Normand used an intervention package, lasting an average of 7.31 weeks (range, 4 – 9 weeks), consisting of self-monitoring, goal setting, and feedback to increase the physical activity of five overweight/obese adults enrolled in a weight-loss program. During the intervention phase of this study, participants were required to set daily and/or weekly calorie-expenditure goals, and send their data to the experimenter. They received weekly feedback via email from the experimenter on their performance. Following the initial intervention phase, physical activity increased for all five participants, determined by an increase in the number of calories they burned per day. Three participants experienced a reversal back to baseline (i.e., removal of the intervention package; no goals, feedback, or self-monitoring) during which
INCREASING PHYSICAL ACTIVITY

calorie expenditure decreased for two of the three participants, while one participant
demonstrated an even larger increase in calorie expenditure compared to the initial intervention
phase.

Donaldson and Normand (2009) claim that a major strength of their intervention was its
simplicity. The participants were able to enter their data at home (or in another convenient
location) and overall, the intervention package was non-invasive. Studies that have investigated
similar intervention packages (e.g., Normand, 2008; Wack et al., 2014) have been effective in
increasing physical activity in adults. However, a potential drawback to physical activity
intervention packages like the one used by Donaldson and Normand is the exclusion of a
reinforcement component. Sometimes, the potential natural reinforcers associated with physical
activity (i.e., weight loss, improvements in health and strength, better fitting clothes) may not be
enough to sustain long-term physical activity. In these cases, the addition of a reinforcement
component, such as financial compensation, to an intervention package could promote even
larger increases in physical activity compared to intervention packages that did not include
reinforcement (e.g., Donaldson & Normand; Wack et al.). Previous research on interventions to
promote physical activity, such as contingency management (Donlin Washington, Banna, &
Gibson, 2014), have been effective in promoting healthy behavior change. Reinforcement (e.g.,
financial compensation) may promote long-term maintenance of physical activity, especially if
the readily available, potential natural reinforcers associated with physical activity are
insufficient at doing so, which would have significant public health implications. If
reinforcement (e.g., financial compensation) promotes the most substantial behavior change,
organizations like gyms, workplaces, or insurance companies may be able to implement simple
interventions to promote physical activity, prevent illnesses, and offset the economic costs related to physical inactivity.

**Financial incentives.** A commonly researched method for increasing physical activity in both the behavior analytic and non-behavior analytic literature is the use of financial incentives (e.g., Adams et al., 2017; Burns & Rothman, 2018; Fennell, Gerhart, Seo, Hague, & Glickman, 2016; Hunter, Tully, Davis, Stevenson, & Kee, 2013; Losina et al., 2017; Schumacher et al., 2013; Patel et al., 2016). Research suggests that how and when financial compensation is delivered and earned may be relevant to the efficacy of physical activity interventions (e.g., Adams et al.; Burns & Rothman; Patel et al.).

For example, in an eight-week intervention, Burns and Rothman (2018) compared the effects of different types of financial incentives and when they were earned on the number of steps taken per day for adults. Financial compensation was contingent on taking 10,000+ steps per day on four or more days per week. Depending on the group they were assigned to, participants were able to a) earn $10 each week for meeting the goal (i.e., fixed cash group), b) earn $0-$20 each week for meeting the goal (i.e., variable cash group), c) lose $10 each week from an initial $50 for not meeting the goal (i.e., fixed deposit group), or d) lose $0-$20 each week from an initial $50 for not meeting the goal (i.e., variable deposit group). Participants were also assigned to a control group, where no financial incentives were earned. Burns and Rothman found that participants took, on average, more steps per day in the groups in which they received financial compensation compared to the control group; however, there were no differences in the number of steps taken per day between the groups in which financial compensation was earned.

Burns and Rothman’s (2018) findings suggest that the use of financial incentives may be useful for increasing adults’ physical activity. However, Burns and Rothman’s results also
suggest that the arrangement of earning and delivery of financial incentives may influence their effectiveness, although the extent to which remains unclear. In a similar study, Adams et al. (2017) compared the effects of two types of goal setting with either immediate or delayed financial compensation on the number of steps taken per day in a four-month intervention. Participants were able to earn money that was either delivered immediately (i.e., via email every time they accumulated five dollars) or delayed (i.e., at the end of the study) if they met a static goal (i.e., 10,000+ steps per day) or an adaptive goal (i.e., 60th percentile criterion). Adams and colleagues found that participants who received immediate financial compensation based on meeting static goals had a higher average daily step count compared to participants receiving delayed compensation and/or adaptive goals. The results of Adams et al. suggest that the schedule of delivery of financial compensation influences adults’ levels of physical activity. These results contrast with those of Burns and Rothman, who did not find any significant differences in the influence of how and when financial compensation was delivered on increasing physical activity. A potential reason why the results of Adams and colleagues differed from Burns and Rothman is inconsistencies in how immediate and delayed rewards were defined, although this remains unclear.

To date, the results on the effectiveness of financial incentives to increase adults’ physical activity remain mixed; thus, we cannot make any firm conclusions on the most appropriate ways to deliver financial compensation during physical activity interventions. However, there may be an optimal combination of how and when financial compensation is earned and delivered for increasing physical activity. If such an optimal combination exists, efforts to systematically investigate different aspects of financial incentives and their effects on increasing physical activity should continue.
**Contingency management.** Contingency management is a behavioral technique that enables individuals to earn access to a preferred item or activity contingent on meeting or exceeding goals or other objective criteria. Frequently, financial incentives are used as the preferred item in contingency-management interventions. Contingency management has been used with a variety of populations and behavior. For example, it has been used to promote smoking abstinence in adults (e.g., Dallery & Glenn, 2005; Dallery, Glenn, & Raiff, 2007; Meredith, Grabinski, & Dallery, 2011), to increase healthy behavior in HIV-Positive patients (Petry, Weinstock, Alessi, Lewis, & Dieckhaus, 2010), and to increase physical activity in adults (e.g., Andrade, Barry, Litt, & Petry, 2014; Donlin Washington et al., 2014; Donlin Washington, McMullen, & Devoto, 2016; Kurti & Dallery, 2013; Mann, 1972; Wysocki, Hall, Iwata, & Riordan, 1979).

There are two critical components to contingency-management interventions. First, the target behavior must be observable and measurable. In the context of physical activity, the target behavior may be a specific activity (e.g., running) or some observable and measurable indicator of physical activity (e.g., step count, calorie expenditure). Second, a reinforcer (e.g., money or gift cards) must be delivered following the emission of the target behavior or withheld if the target behavior did not occur. For example, if the participant runs for a predetermined length of time or reaches a predetermined number of daily steps, then they may earn a preferred item (i.e., reinforcer), such as money. If the participant fails to run for a predetermined length of time or reach a predetermined number of daily steps, they will not earn the item. Reinforcement is a critical component of contingency-management interventions, so it is essential for experimenters to use items and activities that participants prefer and that will function as reinforcers to maintain desirable behavior. Incentives that have been used in previous contingency management research...
include money (e.g., Cohen, Paradis, & LeMura, 2007; Donlin Washington et al., 2016; Kurti & Dallery, 2013), tokens or points (e.g., Wysocki et al., 1979), and prize lotteries (e.g., Donlin Washington et al., 2014).

Contingency-management interventions have been successful at promoting physical activity. For example, Donlin Washington et al. (2014) conducted a study in which they evaluated the influence of a lottery-based contingency on adults’ step counts over a three-week period. During the two baseline phases, participants earned entries into a prize lottery contingent on wearing a Fitbit device every day. Prizes in the baseline drawing consisted of praise and items worth approximately $5. During the intervention phase, participants earned entries in the lottery contingent on meeting minimum step-count goals set by the experimenters. Available prizes included praise, small prizes (i.e., worth up to $5), medium prizes (i.e., worth up to $15), large prizes (i.e., worth up to $50) or a jumbo prize (i.e., worth up to $120). Donlin Washington and colleagues found that daily step counts increased during the intervention phase in relation to baseline levels.

Other studies have found prize-draw contingencies to be successful in changing health-related behavior (e.g., Byrne, Barry, & Petry, 2012; Petry et al., 2004). In the study by Donlin Washington et al. (2014), participants earned opportunities to be entered in a prize lottery contingent on meeting daily step-count goals. The prize lottery included all participants enrolled in the study. That is, the probability of a participant winning a prize depended on the behavior of other participants (i.e., if the number of participants meeting goals was high, the probability of winning was low). Essentially, all of the participants were “competing” against each other to earn prizes. It is possible that if participants were aware of this “competition,” it may have contributed to the increases in daily step counts, making it unclear whether the opportunity to
win prizes with a larger monetary value had any effect on behavior. However, whether participants were aware of this “competition” was not made clear by the authors.

Future research should investigate whether there are differential effects on physical activity when using group prize lotteries (i.e., a participant is entered in a prize lottery that includes all other participants enrolled in the study) or individual prize lotteries (i.e., each participant is entered in their own prize lottery, where the probability of winning does not depend on the behavior of other participants). In addition, the prizes used in Donlin Washington et al. (2014) were worth between $0 and $120. When considering the feasibility of a large-scale application of this intervention, one must account for the cost of the program, including reinforcers. It is possible that prizes of larger value (i.e., $120) would be costly and difficult to provide to participants over a long period of time. If the desired result of a contingency-management intervention is more real or perceived control over reinforcing outcomes, creating individual prize draws may increase motivation, more effectively use small prizes (i.e., worth up to $5), and reduce the need for more costly prizes (e.g., worth up to $120). If prizes with a small monetary value are more practical, this may lead to implications (e.g., reaching a large number of people, long-term implementation) for organizations that want to promote physical activity (e.g., gyms, workplaces, insurance companies).

**Purpose**

While there are various behavior-change techniques that can be used to increase physical activity in adults, several gaps in the literature remain. To our knowledge, there are only a handful of studies (e.g., Byrne et al., 2012; Donlin Washington et al., 2014; Patel et al., 2016; Petry et al., 2004) investigating the use of lottery-based financial incentives or contingency management for increasing physical activity. Another limitation of the current literature base is
that studies (e.g., Donlin Washington, et al.; Patel, et al.) most often involve short-term interventions lasting for approximately one month. Thus, the long-term effects of lottery-based incentives and contingency management on increasing physical activity remain ambiguous. In addition, the current literature remains mixed on the effectiveness of prizes and financial incentives used in lottery-based interventions for increasing physical activity. For example, it is uncertain if incentives of smaller, larger, or varied values will differentially influence the degree to which an individual can increase their physical activity. Specifically, it is possible that incentives of varying or large values may not be practical for individuals or organizations wanting to incentivize healthy behavior over a longer period of time (e.g., several months), however, this remains unclear.

Much is still unknown about how to best increase physical activity. However, we do know that to mitigate the negative health and economic implications related to physical inactivity, effective, large-scale interventions must be developed. Currently, there is variability in how physical activity interventions are designed and how data from those interventions are displayed and interpreted. Therefore, the purpose of the current study is to further investigate the utility of an incentive-based physical activity intervention using prize-based contingency management to provide more information on how best to promote physical activity for individuals living in the United States.

**Method**

**Participants**

We enrolled 42 adults between the ages of 18 and 64 years in the current study. Thirty-nine participants completed the study, and three voluntarily withdrew. Our sample \( (N = 39) \) consisted of 28 (71.79%) females and 11 (28.21%) males. Thirty (76.92%) participants identified
as White. Five (12.82%), two (5.13%), and one (2.56%) participants identified as Asian, African American, and African, respectively. The average age of participants in this study was 26.66 years old ($SD = 9.09$; range, 19-56) and the majority of participants reported “some college” as their highest level of education.

The demographic characteristics for each group are displayed in Table 1. In the Contingency Management (CM) group ($n = 13$), 11 (84.62%) participants were female and 2 (15.38%) were male, the average age was 25.69 years old, 11 (84.62%) participants identified as White, and the majority of participants (53.85%) reported “some college” as their highest level of education. In the Participation-Based Incentive (PBI) group ($n = 13$), 9 (69.23%) participants were female and 4 (30.77%) were male, the average age was 28.69 years old, 7 (53.85%) participants identified as White, and the majority of participants (53.85%) reported “some college” as their highest level of education. In the Self-Monitoring (SM) group ($n = 13$), 9 (69.23%) participants were female and 4 (30.77%) were male, the average age was 25.38 years old, 12 (92.31%) participants identified as White, and the majority of participants (46.15%) reported “some college” as their highest level of education.

A chi-square goodness of fit test was used to determine if groups were significantly different across gender, race/ethnicity, and level of education before the start of the study. We found that groups were not significantly different by gender and level of education; however, the distribution of race/ethnicity was significantly different across groups, $X^2 (2, N = 39) = 6.07, p = .05$. Thus, because groups significantly differed by race/ethnicity before the beginning of the study, we included it as a covariate in subsequent statistical analyses.

We conducted a one-way analysis of variance (ANOVA) to determine if groups were significantly different by age at the start of the study, and found that there were no significant
INCREASING PHYSICAL ACTIVITY

differences, $F (2, 38) = .51, p = .60$, partial $\eta^2 = .03$. Before the start of the intervention phase, we ran one-way ANOVAs to determine if groups were significantly different by daily calorie expenditure, step count, and active min during the baseline phase. There were no significant differences between groups during baseline by daily calorie expenditure, $F (2, 39) = .47, p = .63$, partial $\eta^2 = .02$; daily step count, $F (2, 39) = 1.5, p = .24$, partial $\eta^2 = .07$; or daily active min, $F (2, 39) = .61, p = .55$, partial $\eta^2 = .03$.

**Recruitment.** We recruited participants using email advertisements through West Virginia University (WVU), flyers posted in and around WVU buildings, websites (e.g., Facebook, Craigslist), and classroom advertisements. Before the start of the study, we conducted a power analysis for within- and between-subjects ANOVA using a conservative effect size (Cohen’s $f = 0.15$; Cohen, 1988), a moderate correlation between repeated measures ($r = 0.05$), a power value of .80, and a Type I error rate of 0.05. The results of the power analysis suggested that a sample size of 39 was required to see an effect.

**Informed consent and screening.** During the initial meeting, the experimenter guided participants through the informed consent and screening process. First, the experimenter reviewed the consent form with participants and allowed them to read through it independently. Afterwards, the experimenter gave participants an opportunity to ask any questions they had about the study. Once all parties signed the consent form, each participant completed four questionnaires to determine if they were eligible to participate in the study. First, participants filled out a basic demographic questionnaire (see Appendix A), containing questions such as “What is your age?” and “Are you, or is there a chance that you may be, pregnant?” Next, participants filled out the International Physical Activity Questionnaire (Craig et al., 2003; see Appendix B) to screen for individuals who already engaged in greater than the recommended
INCREATING PHYSICAL ACTIVITY

amount of physical activity in a week. The third questionnaire was the 2017 Physical Activity Readiness Questionnaire for Everyone (Warburton et al., 2011; see Appendix C), which screened for physical conditions that would prevent them from engaging in increased physical activity. Last, participants filled out the Eating Disorder Examination Questionnaire 6.0 (Fairburn & Beglin, 2008; see Appendix D), which screened for potential eating disorders.

Inclusion criteria. To be eligible for the study, participants needed to meet several inclusion criteria. Participants had to have a smartphone (e.g., iPhone or Android) or another device (e.g., iPad) compatible with the Fitbit application and access to a computer with Internet. On the demographic questionnaire, participants needed to report that they were not pregnant and that they had not used a fitness tracker within the last 60 days. Participants also needed to report engaging in 125 min or less of physical activity per week on the International Physical Activity Questionnaire (Craig et al., 2003). Additionally, participants had to answer “No” to all questions on the 2017 Physical Activity Readiness Questionnaire for Everyone (Warburton et al., 2011). However, if participants responded “Yes” to question four, and reported that they had a psychiatric diagnosis (e.g., anxiety, depression, attention-deficit hyperactivity disorder), they were able to participate as long as they also reported that the condition was controlled by therapy, medication, or a combination of the two. Participants also had to receive a global score of less than 2.0 on the Eating Disorder Examination Questionnaire 6.0 (Fairburn, 2008; Mond, Hay, Rogers, & Owen, 2006). Of the 161 participants that were consented and screened, 42 (26.09%) were eligible and 119 (73.91%) were ineligible. Of the 119 participants that were ineligible, 97 (81.51%) were excluded because they engaged in more than 125 min of physical activity per week, 12 (10.08%) were excluded because they answered “yes” to at least question on the Physical Activity Readiness Questionnaire for Everyone, 5 (4.2%) were excluded because
they reported tracking their fitness within the past 60 days, and 5 (4.2%) were excluded because they scored greater than 2.0 on the Eating Disorder Examination Questionnaire. If participants did not meet any of the inclusion criteria, we informed them that they did not meet our eligibility requirements and thanked them for their time. If participants were eligible and wanted to continue participating, we asked them to list the most convenient times when they could charge their Fitbit device. We then asked participants to charge their devices based on those times.

Study termination criteria. Participation in the current study was voluntary, thus participants had the opportunity to withdraw at any point. Three participants voluntarily withdrew from the study. Two participants withdrew after the first few days of the baseline phase because they were unable to wear the Fitbit daily due to work uniform requirements. The other participant withdrew following approximately six weeks of intervention because he was unable to wear the Fitbit daily due to preferred leisure activities (e.g., surfing). The experimenters reserved the right to terminate an individual’s participation if they failed to comply with study procedures (e.g., wearing their Fitbit device, keeping the device charged) on three or more occasions. No one was terminated from the study.

Materials

We used Fitbit Alta HR fitness-tracking devices to monitor and record daily calorie expenditure, step count, time spent in each activity zone, and heart rate. Participants’ age, gender, height, and weight were entered into the Fitbit device at the initial appointment. Although we took periodic weight measurements throughout the study, we did not update the participants’ weight data on the Fitbit device. We believed that changes in weight were not going to be substantial enough to change any physiological measurements (e.g., calorie expenditure, heart rate). Another reason for not updating weight on the Fitbit device was to avoid weight
updates coinciding with phase changes. The Fitbit devices used the participants’ basal metabolic rate (calculated by age, gender, height, and weight) and continuous heart rate to calculate how many calories they expended per day. The Fitbit device automatically synchronized with the smartphone application and the Fitbit website; therefore, we were able to collect and analyze data remotely and daily information was available in real time. During the in-person appointments, we manually calculated the participants’ resting heart rate. We used a digital scale to measure the participants’ weight and an Omron 5 Series Upper Arm Blood Pressure Monitor to measure their blood pressure.

**Dependent Measures and Data Collection**

Our primary dependent measure was calorie expenditure, defined as the total number of calories burned over a 24-hr day. We used Fitbit Alta HR fitness tracking devices to collect data on the number of calories expended per day. Participants wore their Fitbit devices at all times (e.g., during daily activities such as sleeping, working, etc.), except when showering (i.e., the device is not waterproof) or charging the device. For each participant, we graphed the number of calories that were expended each day.

We chose calorie expenditure as our primary dependent variable because it has several advantages over weight loss or step count as an indicator of improved health and increased physical activity. Calorie expenditure is considered a more sensitive measure of physical activity compared to step count because it captures a wider variety of physical activity (e.g., strength training, yoga, etc.) in addition to walking or running. Additionally, previous research suggests that when weight loss is used as a primary dependent measure, participants may resort to extreme behaviors (e.g., laxative or diuretic use) to lose weight rapidly before weigh-ins (Mann, 1972). Previous research also suggests that individuals may experience improvements in their health
despite weight loss/gain; therefore, weight is not a necessary indicator of improvements in health (Millstein, 2014; Wildman et al., 2008). In the current study, we took weight measurements, but we did not expect participants to engage in risky weight-loss behaviors because it was not the primary variable of interest, there were no goals related to weight loss, nor were there any programmed consequences for changes in weight.

Our secondary dependent measures included a) step count, defined as the number of steps taken in a 24-hour day; b) active min, defined as the number of min spent engaging in an activity where an individual’s calorie expenditure is three times greater than it is when they are at rest; c) time spent in the Fat Burn activity zone (i.e., time spent engaging in moderate physical activity; defined as the number of min during which a participant’s heart rate is 50-70% of their maximum heart rate) and the Cardio and Peak activity zones (i.e., time spent engaging in vigorous physical activity; defined as the number of min where a participant’s heart rate is 70-100% of their maximum heart rate); d) resting heart rate, defined as the number of heart beats per minute while an individual is at complete rest; and e) weight. We used the Fitbit devices to collect data on step count, active min, and the number of min spent in each activity zone (i.e., Fat Burn, Cardio, and Peak). We used a digital scale to monitor weight, and we manually calculated resting heart rate.

**Interobserver Agreement and Treatment Integrity**

We collected data on daily calorie expenditure, step count, the number of min spent in each activity zone, and active min using the Fitbit devices, which automatically synched to the Fitbit smartphone application and website. Therefore, interobserver agreement data were not necessary for these measures. To monitor the primary experimenter’s accurate implementation of the experimental procedures, a second experimenter used a treatment integrity checklist. For a
description of treatment integrity components, see the attached treatment integrity checklists (Appendices E-H). Treatment integrity was calculated by taking the number of components implemented correctly, dividing by the total number of components, and multiplying by 100. A laboratory assistant collected treatment integrity data for 25% of days across participants in each group and found that the experimenter implemented the study procedures with 100% accuracy.

**Experimental Design**

We used a between-groups design in the current study. The intervention phase lasted for eight weeks, during which we compared three experimental groups, each consisting of 13 participants. We assigned participants to groups using restricted randomization (Baily, 1983). Restricted randomization allowed us to ensure that an equal number of participants were assigned to each group and helped to control for potential confounds (e.g., the majority of participants who reported engaging in the least amount of physical activity during screening getting assigned to the same group). To assign participants to groups, the experimenter created a list of each group based on a block size of three, such that the same group could not occur in the list more than twice in a row. Each participant was semi-randomly assigned to each group per the order on the experimenter’s list following consent and screening. No more than two consecutive participants were assigned to the same group.

**Procedures**

**Weight, blood pressure, and heart rate monitoring.** Participants’ weight, blood pressure, and resting heart rate were monitored and recorded at several points throughout the study. Each was measured at the initial meeting (i.e., consent and screening), at the completion of baseline (approximately 2- to-3 weeks following the initial appointment), and at the completion of the study. Final appointments were supposed to occur one day to two weeks
following the last day of the intervention phase, however, final appointments actually occurred between one day and three months ($M = $ seven days) following the last day of the intervention phase. If participants wanted to come in to check these measures, they were welcome to do so a maximum of seven additional times; however, no participants did this. To monitor and record weight, the experimenter asked the participant to remove his or her shoes and step onto a digital scale. The experimenter recorded the number (in kg) shown on the screen. To monitor and record blood pressure, the experimenter used an Omron 5 Series Upper Arm Blood Pressure Monitor. To calculate resting heart rate, the experimenter placed two fingers on the participants’ wrist, counted the number of beats that occurred in 15 s, and multiplied that number by four.

**Baseline.** The purpose of the baseline condition was to get an accurate measurement of daily calorie expenditure in the absence of any intervention. Following the initial screening, the experimenter gave each participant a Fitbit Alta HR fitness-tracking device with the screen covered. Participants were unable to track their fitness data (e.g., calorie expenditure, step count, etc.) during the baseline phase. Participants did not have access to account information and the app was blinded (i.e., they could not access any of their data on the app). To try to prevent reactivity to the Fitbit device, the baseline phase lasted for a minimum of 14 days. The experimenter began the intervention once there were no trends in the baseline data for the last six days.

**Fitbit setup.** Following baseline, the experimenter contacted participants in this group to schedule a meeting. At this meeting, the experimenter removed the tape covering the screen of the Fitbit device, provided the participant with the login information for the account associated with their Fitbit, and enabled them to see their data via the app. The experimenter also gave the participants a brief tutorial on how to use the Fitbit device using the information in the device.
manual. The device manual was not given to participants. Instead, the experimenter encouraged participants to contact them if they had any technical difficulties with the device.

**Contingency management (CM) group.** The purpose of the CM group was to investigate whether participants increased their physical activity as a result of earning Amazon gift cards for meeting specific calorie-expenditure goals.

**Goal setting.** For each participant in the CM group, the experimenter set individualized calorie-expenditure goals. Goals were calculated for each participant using a percentile schedule. Specifically, the experimenter used the 70th percentile to calculate goals. Research suggests that the 70th percentile is optimal because it generates goals that the participant can meet while still promoting increases in the target behavior (Galbicka, 1994).

The experimenter calculated the goals in the following manner. First, the experimenter put the calorie-expenditure totals from the previous 14 days in order from smallest to largest. Then the experimenter multiplied the number of days (i.e., 14) by 0.7. This resulted in the index (i.e., 10). The experimenter used the index to identify the 70th percentile. In this case, the 70th percentile was the number of calories that were expended on the 10th day in the set. The experimenter initially calculated goals using participants’ baseline data. All subsequent goals were calculated using the data from the previous 14 days. Each goal period lasted four days.

If a participant met their goal for 75% of days (i.e., 3 out of 4 days), the experimenter increased their goal for the next goal period. If a participant met their goal on 33% to 50% of days (i.e., 1- to-2 out of 4 days), the experimenter kept their goal the same for the next goal period. If a participant did not meet their goal at all during a goal period, the experimenter decreased their goal for the next goal period. In situations where the experimenter needed to decrease goals, they used the same goal from the most recent goal period (i.e., if it was the first
goal period) or the same goal from the most recent goal period during which the participant was successful on at least 75% of days. Participants in this group were notified of their upcoming goals within 12 hr of the start of each four-day goal period via text message (using EZ Texting text message software).

**Reinforcement.** For each day a participant in the CM group met or exceeded the daily calorie-expenditure goal, they earned a ticket for a lottery to win a $5 Amazon gift card. On days where a participant met or exceeded their calorie goal, they were notified via text message that they had been entered in a lottery to win an Amazon gift card. In this case, the experimenter put a slip of paper with the participant’s identification number on it into a bowl. On days where a participant did not meet or exceed their calorie-expenditure goal, they were notified that they missed the opportunity to be entered in the gift-card lottery. In this case, the experimenter put a blank slip of paper into a bowl.

The lottery for each participant did not include any other participants enrolled in the study. That is, participants were entered in their own lottery and their chance to win did not depend on the behavior of any other participant in the study. Drawings occurred every seven days, where the experimenter drew a slip of paper from each participant’s lottery bowl. If the experimenter drew a slip with the participant’s ID number on it (indicating a day where they met their goal), they sent the gift card via email. If the experimenter drew a blank slip (indicating a day where the participant did not meet their goal), they notified the participant that they did not win a gift card via text message. Following each lottery drawing, participants started over with seven new opportunities to win a gift card.
Participation-based incentive (PBI) group. The purpose of the PBI group was to investigate whether participants would increase their physical activity as a result of receiving an Amazon gift card regardless of how many calories they expended per day. During the intervention phase, participants in the PBI group received a $5 Amazon gift card every seven days via email, regardless of how much physical activity they engaged in. The experimenter did not set any calorie-expenditure goals for participants in this group, nor did they provide any instructions or feedback on how to perform during the intervention phase.

Self-monitoring (SM) group. The purpose of the SM group was to investigate whether participants increased their physical activity as a result of tracking the number of calories they expended in a day. The experimenter did not provide any instructions on how to self-monitor or feedback on their performance. Following the completion of the intervention, participants in the SM group received $20 in Amazon gift cards for their participation.

Data Analysis

We used SPSS version 24 to perform all statistical tests. We checked each variable (i.e., average daily calorie expenditure, average daily step count, average daily active min, the average number of min spent in the Fat Burn, Cardio, and Peak activity zones per day, average resting heart rate, and average weight) for normality based on skew and kurtosis. The average number of active min per day, average number of min spent in each activity zone, and average weight were not normally distributed (i.e., the skew and kurtosis were greater than 3.2) so we transformed them using a square root transformation. The transformed data did not influence the results of the subsequent statistical tests; thus, the results of the raw data are reported in this manuscript.

We conducted a 3 (group) by 2 (time) mixed factorial analysis of covariance (ANCOVA) to determine statistically significant differences in the average number of calories expended per
INCREASING PHYSICAL ACTIVITY

day, the average number of steps taken per day, the average number of active min per day, and the average time spent in each activity zone per day. We conducted a 3 (group) by 3 (time) mixed factorial ANCOVA to determine statistically significant differences in average resting heart rate and average weight. As previously stated, the distribution of race/ethnicity was significantly different across groups at the start of the study, so we included race/ethnicity as a covariate in these analyses. Additionally, we ran one-way ANOVAs on the percent change in average calories burned per day, average steps taken per day, average resting heart rate, average weight, the average difference in the average time spent in each heart rate zone per day, and the average difference in the average number of active min per day. We also ran one-way ANOVAs on the average percent of days on which participants expended more calories compared to the average calories expended during the total baseline phase and the last six days of baseline. The alpha level for all analyses was .05 (α = .05). Effect sizes are reported as partial eta squared (η²), which measures the proportion of the total variance in a dependent variable by an independent variable, whereby the effects of other independent variables and interactions are partialled out.

In addition to the above-mentioned statistical analyses, we used SPSS version 24 to run a time series analysis to describe the trend in the average number of calories expended per day for each group. We also conducted a time series forecast using participant data to predict trends in the average number of calories expended per day for each group for another eight weeks of intervention. We used Prism GraphPad 8 to create all graphs.

Results

Primary Dependent Measure: Calorie Expenditure

Table 2 displays descriptive statistics for the average number of calories expended per day for each group during baseline and intervention. Exploratory analyses demonstrated that the
average number of calories expended during baseline and intervention were normally distributed based on z-scores less than 3.2 for skew and kurtosis. Thus, these data were appropriate for subsequent analysis. In baseline, participants in the CM group expended an average of 2,319.15 calories per day ($SD = 457.67$) and during intervention they expended an average of 2,395.38 calories per day ($SD = 458.84$). Participants in the PBI group expended an average of 2,454.23 calories per day ($SD = 639.74$) during baseline and an average of 2,489.15 calories per day ($SD = 637.32$) during intervention. In baseline, participants in the SM group expended an average of 2,473.38 calories per day ($SD = 571.18$) and during intervention they expended an average of 2,417.54 calories per day ($SD = 504.31$).

We conducted a 3 (group) by 2 (time) mixed factorial ANCOVA with race/ethnicity as a covariate to compare the main effects of group and time, as well as the interactions between group and time on the average number of calories expended per day. Figure 1 displays the means and standard errors for each group at baseline and intervention for the average number of calories expended per day. There was no significant main effect of time on the average number of calories expended per day, $F (1, 35) = 1.17, p = .29, \eta_p^2 = .03$. Although there was no significant main effect of group on the average number of calories expended per day, $F (2, 35) = .77, p = .47, \eta_p^2 = .04$, race/ethnicity (the covariate) significantly influenced the relation between group and the average number of calories expended per day, $F (1, 35) = 4.65, p = .04, \eta_p^2 = .12$. There were no significant interactions between time and race/ethnicity, $F (2, 35) = 1.82, p = .26, \eta_p^2 = .04$ and between time and group, $F (2, 35) = 1.82, p = .18, \eta_p^2 = .09$ on the average number of calories expended per day.

We conducted a 3 (group) by 9 (time) mixed factorial ANCOVA with race/ethnicity as a covariate to compare the main effects of group and time, as well as the interactions between
group and time on the average number of calories expended per day across baseline and each week of the intervention phase. Baseline data were collapsed into one data point, because the number of weeks that participants were in baseline varied. There was no significant main effect of time on the average number of calories expended per day across baseline and each week of intervention, $F(8, 280) = .44, p = .7, \eta^2_p = .01$. There was also no significant main effect of group, $F(2, 35) = .65, p = .53, \eta^2_p = .04$ on the average number of calories expended per day across baseline and each week of the intervention phase. There were no significant interactions between time and race/ethnicity, $F(8, 280) = 1.19, p = .32, \eta^2_p = .03$ and between time and group, $F(16, 280) = .47, p = .81, \eta^2_p = 2.46$ on the average number of calories expended per day.

Figure 2 displays the average percent change in average calories expended per day between the baseline and intervention phases for each group. Table 3 displays the means, ranges, and standard errors for the average percent change in the average number of calories expended per day for each group. Participants in the CM and PBI groups increased the average number of calories that they expended per day from baseline to intervention by 3.51% ($SEM = 1.48\%$) and 1.78% ($SEM = 2.02\%$), respectively. However, the average number of calories expended per day from baseline to intervention for participants in the SM group decreased by 1.47% ($SEM = 2.33\%$). We conducted a one-way ANOVA to compare the average percent change in average calories expended per day between baseline and intervention across groups and there were no significant differences, $F(2, 38) = 1.64, p = .21, \eta^2_p = .08$.

Table 4 and Figure 3 show the average percent of days on which participants expended more daily calories during intervention compared to their total baseline average for each group. Participants in the CM group expended more daily calories during intervention compared to baseline an average of 54.76% ($SEM = 3.65\%$) of days. In the PBI group participants expended
more daily calories during intervention compared to baseline on an average of 49.62% (SEM = 5.11%) of days. Participants in the SM group expended more daily calories during intervention compared to baseline on an average of 40.15% (SEM = 6.59%) of days. Thus, it appears that on average, participants in the CM group expended more daily calories than the baseline average on more days during intervention compared to the PBI and SM groups. However, we ran a one-way ANOVA to compare the average percent of days where participants expended more daily calories during intervention compared to the average calories expended during baseline and there were no significant differences between groups, $F(2, 38) = 1.99, p = .15, \eta^2_p = .09$.

Table 5 and Figure 4 show the average percent of days where participants expended more daily calories during intervention compared to the average calories expended during the last six days of baseline. Participants in the CM group expended more daily calories during intervention compared to the last 6 days of baseline on an average of 59.8% (SEM = 5.09%) of days. In the PBI group participants expended more daily calories during intervention compared to the last 6 days of baseline on an average of 50.75% (SEM = 6.63%) of days. Participants in the SM group expended more daily calories during intervention compared to the last 6 days of baseline on an average of 46.37% (SEM = 7.62%) of days. Participants in the CM group, on average, appeared to have expended more daily calories during intervention compared to the average calories expended during the last 6 days of baseline on more days compared to the PBI and SM groups. However, we ran a one-way ANOVA to compare the average percent of days where participants expended more daily calories during intervention compared to the average calories expended during the last 6 days of baseline and there were no significant differences between groups, $F(2, 38) = 1.1, p = .34, \eta^2_p = .05$. 
Figure 5 shows the results of the time series analysis that was conducted to analyze the trends in the average number of calories expended per day across weeks for each group. The first data point in each of the data paths represents the average number of calories expended per day during the baseline phase. Baseline was collapsed into one data point because the number of weeks that each participant spent in the baseline phase varied. Following baseline, the average number of calories expended per day across weeks increased for participants in the CM and PBI groups, and decreased for participants in the SM group. The data for each group were variable; however, the average number of calories expended per day across weeks for participants in the CM and SM groups did not appear to show large increases or decreases. Thus, the data for these two groups show a simple-seasonal trend. Although variable, the average number of calories expended per day across weeks for participants in the PBI group appear to increase over time, indicating an additive trend.

We then forecasted the trend in the average number of calories expended per day across weeks for each group for an additional 8 weeks using the participant data from the intervention phase. The trend for the CM and SM groups is predicted to stay the same; however, there does seem to be a small increase in the average number of calories expended per day across weeks over time. The trend for the PBI group is predicted to increase over time. The Root Mean Square Error (RMSE) is a coefficient in the time series model that is able to forecast the average daily calories expended per day across weeks within a certain degree of the real data that were collected during the experiment (i.e., goodness of fit). The model predicted the average number of calories expended per day across weeks within 24.48 calories for the CM group, 40.64 calories for the PBI group, and 32.58 calories for the SM group.
Secondary Dependent Measures

Steps. Table 2 displays descriptive statistics for the average number of steps taken per day for each group in baseline and intervention. Exploratory analyses demonstrated that the average number of steps taken per day during baseline and intervention were normally distributed based on z-scores less than 3.2 for skew and kurtosis. Thus, these data were appropriate for subsequent analyses. In the baseline phase, participants in the CM group took an average of 7,283.38 steps per day (SD = 2,243.35) and during the intervention phase they took an average of 8,322.69 steps per day (SD = 1,928.54). Participants in the PBI group took an average of 6,112.46 steps per day (SD = 1,646.92) during baseline and an average of 6,433.62 steps per day (SD = 1,356.94) during intervention. In baseline, participants in the SM group took an average of 7,289.62 steps per day (SD = 1,773.07) and during intervention they took an average of 7,206.15 steps per day (SD = 1,777.31).

We ran a 3 (group) by 2 (time) mixed factorial ANCOVA with race/ethnicity as a covariate to compare the main effects of group and time, as well as the interactions between group and time on the average number of steps taken per day. Figure 6 displays the means and standard errors for the average number of steps taken per day per group during baseline and intervention. There was no significant main effect of time on the average number of steps taken per day, F (1, 35) = .04, p = .85, η² = .001. There was also no main effect of group, F (2, 35) = 2.23, p = .12, η² = .11 on the average number of steps taken per day. There were no significant interactions of time and race/ethnicity, F (1, 35) = .09, p = .76, η² = .003 and time and group, F (2, 35) = 1.3, p = .29, η² = .07 on the average number of steps taken per day.

Figure 7 displays the average percent change in average steps taken per day between baseline and intervention. Table 3 shows the means, ranges, and standard errors for the average
percent change in the average steps taken per day for each group. Participants in the CM group took 21.49% \( (SEM = 8.59\%) \) more steps per day during the intervention phase compared to the baseline phase. This was similar to participants in the SM group, who took, on average, 21.19% \( (SEM = 23.62\%) \) more steps per day during the intervention phase compared to the baseline phase. Participants in the PBI group took, on average, 10.68% \( (SEM = 7.54\%) \) more steps per day during the intervention phase compared to the baseline phase, which is less than that of the CM and SM groups. We ran a one-way ANOVA to compare the average percent change in average steps taken per day between baseline and intervention across each group, and there were no significant differences, \( F (2, 38) = 0.17, p = .85, \eta_p^2 = .01. \)

**Active minutes.** Table 2 displays descriptive statistics for the average number of active min per day for each group in baseline and intervention. Exploratory analyses demonstrated that the average number of active min per day during baseline and intervention were not normally distributed based on z-scores less than 3.2 for skew and kurtosis. Thus, we used a square-root transformation for these data. This transformation did not affect the outcome of subsequent statistical analyses, so the transformed data are not reported here. In baseline, participants in the CM group were considered active an average of 25.31 min per day \( (SD = 17, \text{median} = 22, \text{range} = 63) \) and during intervention they were active an average of 28.85 min per day \( (SD = 15.33, \text{median} = 24, \text{range} = 55) \). Participants in the PBI group were active for an average of 15.85 min per day \( (SD = 9.34, \text{median} = 17, \text{range} = 31) \) during baseline and an average of 20.85 min per day \( (SD = 11.47, \text{median} = 19, \text{range} = 39) \) during intervention. In baseline, participants in the SM group were active for an average of 28.38 min per day \( (SD = 19.55, \text{median} = 22, \text{range} = 66) \) and during intervention for an average of 26.85 min per day \( (SD = 22.54, \text{median} = 22, \text{range} = 71) \).
INCREASING PHYSICAL ACTIVITY

We conducted a 3 (group) by 2 (phase) mixed factorial ANCOVA with race/ethnicity as a covariate to compare the main effects of group and time, as well as the interactions between group and time on the average number of active min per day. Figure 8 displays the means and standard errors for the average number of active min per day per group during baseline and intervention. There was no significant main effect of time on the average number of active min per day, $F(1, 35) = .29, p = .59, \eta_p^2 = .01$. There was also no main effect of group, $F(2, 35) = .77, p = .47, \eta_p^2 = .04$ on the average number of active min per day. There were no significant interactions of time and race/ethnicity, $F(1, 35) = .34, p = .57, \eta_p^2 = .01$ and time and group, $F(2, 35) = .53, p = .59, \eta_p^2 = .03$ on the average number of active min per day.

Figure 9 displays the average differences in active min per day between baseline and intervention for each group. Table 6 shows the means, ranges, and standard errors for the average differences in the average number of active min per day for each group. Participants in the CM group were active an average of 3.54 ($SEM = 2.73$) more min during intervention compared to baseline. Participants in the PBI group were active an average of 5 ($SEM = 2.89$) more min during intervention compared to baseline. For the participants in the SM group, the number of active min per day decreased, as they were less active by an average of 1.54 min ($SEM = 5.26$) during intervention compared to baseline. We ran a one-way ANOVA to compare the average difference in the average number of active min per day between baseline and intervention across each group and there were no significant differences, $F(2, 38) = .81, p = .45, \eta_p^2 = .04$.

Time spent in each activity zone (heart rate). Table 7 displays descriptive statistics for the average number of min spent in the Fat Burn, Cardio, and Peak activity zones per day for each group in baseline and intervention. Exploratory analyses demonstrated that the average number of min spent in each activity zone per day during baseline and intervention were not
INCREASING PHYSICAL ACTIVITY

normally distributed based on z-scores less than 3.2 for skew and kurtosis. Thus, we used a
square-root transformation for these data. This transformation did not affect the outcome of
subsequent statistical analyses, so the transformed data are not reported here.

In the baseline phase, participants in the CM group spent an average of 256.46 min, 3.46
min, and .46 min per day (SD = 161.71, 4.89, & .88) in the Fat Burn, Cardio, and Peak activity
zones, respectively. During the intervention phase participants in the CM group spent an average
of 264.46 min, 5.54 min, and .54 min per day (SD = 183.81, 7.88, & .78) in the Fat Burn, Cardio,
and Peak activity zones, respectively. Participants in the PBI group spent an average of 207 min,
3.23 min, and .08 min per day (SD = 236.26, 5.48, & .28) in the Fat Burn, Cardio, and Peak
activity zones, respectively during baseline and an average of 232.08 min, 4.54 min, and .23 min
per day (SD = 225.66, 7.46, and .44) in the Fat Burn, Cardio, and Peak activity zones,
respectively during intervention. In the baseline phase, participants in the SM group spent an
average of 161.54 min, 3.08 min, and .46 min per day (SD = 90.66, 3.71, & .66) in the Fat Burn,
Cardio, and Peak activity zones, respectively. During the intervention phase participants in the
SM group spent an average of 165.38 min, 2.54 min, and .46 min per day (SD = 83.78, 2.9, &
.78) in the Fat Burn, Cardio, and Peak activity zones, respectively.

We conducted a 3 (group) by 2 (phase) mixed factorial ANCOVA with race/ethnicity as a
covariate for each of the activity zones (i.e., Fat Burn, Cardio, and Peak) to compare the main
effects of group and time, as well as the interactions between group and time on the average
number of min spent in each activity zone per day. Figures 10, 11, and 12 display the means and
standard errors for the average number of min spent in the Fat Burn, Cardio, and Peak activity
zones, respectively, for each group during baseline and intervention. There was no significant
main effect of time on the average number of min spent in the Fat Burn, F (1, 35) = .61, p = .44,
INCREASING PHYSICAL ACTIVITY

η² = .02, Cardio, \( F(1, 35) = .01, p = .92, \) η² = .00, and Peak, \( F(1, 35) = .66, p = .42, \) η² = .02 activity zones per day. There was also no main effect of group on the average number of min spent in the Fat Burn zone, \( F(2, 35) = .98, p = .38, \) η² = .05, Cardio, \( F(2, 35) = .31, p = .74, \) η² = .02, or Peak zone, \( F(2, 35) = 2.06, p = .14, \) η² = .11 per day. There were no significant interactions of time and race/ethnicity on the average number of min spent in the Fat Burn, \( F(1, 35) = .93, p = .34, \) η² = .03, Cardio, \( F(1, 35) = .14, p = .71, \) η² = .00, and Peak, \( F(1, 35) = .92, p = .34, \) η² = .03 activity zones per day. There were no significant interactions of time and group on the average number of min spent in the Fat Burn, \( F(2, 35) = .13, p = .88, \) η² = .01, Cardio, \( F(2, 35) = 1.37, p = .27, \) η² = .07, and Peak, \( F(2, 35) = .01, p = .99, \) η² = .00 activity zones per day.

Figure 13 displays the average differences in the min spent in the Fat Burn, Cardio, and Peak activity zones per day between baseline and intervention for each group. Table 6 shows the means, ranges, and standard errors for the average differences in the average number of min spent in each activity zone per day for each group. Participants in the CM (\( M = 8 \) min, \( SEM = 19.73 \) min), PBI (\( M = 25.08 \) min, \( SEM = 17.4 \) min), and SM (\( M = 3.92 \) min, \( SEM = 11 \) min) groups spent more time in the Fat Burn zone compared to the Cardio (CM: \( M = 2.08 \) min, \( SEM = 1.15 \) min; PBI: \( M = 1.31 \) min, \( SEM = .72 \) min; SM: \( M = -.54 \) min, \( SEM = 1.3 \) min) and Peak (CM: \( M = .08 \) min, \( SEM = .31 \) min; PBI: \( M = .15 \) min, \( SEM = .1 \) min; SM: \( M = .08 \) min, \( SEM = .27 \) min) activity zones. We ran one-way ANOVAs to compare the average differences in the average number of min spent in the Fat Burn, Cardio, and Peak activity zones per day between baseline and intervention across each group. There were no significant differences between groups in the average difference in the average number of min spent in the Fat Burn, \( F(2, 38) = \)
Resting heart rate. The average resting heart rate for each group before the start of the study, at the end of the baseline phase, and at the end of the intervention phase is displayed in Table 8. Exploratory analyses demonstrated that the average resting heart rate before the start of the study, at the end of the baseline phase, and at the end of the intervention phase was normally distributed based on z-scores less than 3.2 for skew and kurtosis. Thus, these data were appropriate for subsequent analysis. Before the start of the study participants in the CM group had an average resting heart rate of 80 bpm ($SD = 10.26$), following the baseline phase participants had an average resting heart rate of 81.62 bpm ($SD = 10.4$), and following intervention participants in the CM group had an average resting heart rate of 86.08 bpm ($SD = 12.67$). Before the start of the study participants in the PBI group had an average resting heart rate of 80.27 bpm ($SD = 9.92$), following the baseline phase participants in the PBI group had an average resting heart rate of 82.55 bpm ($SD = 11.93$), and following intervention participants had an average resting heart rate of 83.55 bpm ($SD = 14.22$). Before the start of the study participants in the SM group had an average resting heart rate of 72.38 bpm ($SD = 11.60$), following the baseline phase participants had an average resting heart rate of 78.15 bpm ($SD = 12.97$), and following intervention they had an average resting heart rate of 84.85 bpm ($SD = 21.24$).

We conducted a 3 (group) by 3 (time) mixed factorial ANCOVA with race/ethnicity as a covariate to compare the main effects of group and time as well as the interactions between group and time on average resting heart rate. Two participants (both in the PBI group) were excluded from the analysis because there were no resting heart rate data collected at the final appointment (i.e., the final appointment occurred greater than three months from the last day of
increasing physical activity). There was a main effect of time on average resting heart rate, $F(2, 66) = 3.36, p = .05, \eta_p^2 = .09$. Bonferroni corrected post hoc tests showed that average resting heart rate significantly differed between pre-baseline and post baseline measurements ($p = .01$), average resting heart rate significantly differed between pre-baseline and post-intervention measurements ($p = .001$), and average resting heart rate did not significantly differ between post-baseline and post-intervention measurements ($p = .58$). Although there was no main effect of group on average resting heart rate, $F(2, 33) = 1.36, p = .27, \eta_p^2 = .08$, race/ethnicity (the covariate) significantly influenced the relation between group and average resting heart rate, $F(1, 33) = 5.09, p = .03, \eta_p^2 = .13$. There were no significant interactions of time and race/ethnicity, $F(2, 66) = .29, p = .72, \eta_p^2 = .01$ or time and group, $F(4, 66) = .85, p = .48, \eta_p^2 = .05$ on average resting heart rate.

Figure 14 displays the average percent change in resting heart rate between pre-baseline and post-intervention measurements. Table 3 shows the means, ranges, and standard errors for the average percent change in average resting heart rate for each group. For participants in all groups, the average resting heart rate increased between pre-baseline and post-intervention measurements. Participants in the SM group experienced the largest increase in resting heart rate between pre-baseline and post-intervention measurements. We conducted a one-way ANOVA to compare the average percent change in resting heart rate between pre-baseline and post-intervention measurements across groups, and there were no significant differences, $F(2, 36) = 2.14, p = .13, \eta_p^2 = .11$.

**Weight.** The average weight in kg for each group before the start of the study, at the end of the baseline phase, and at the end of the intervention phase is displayed in Table 9. Exploratory analyses demonstrated that the average weight in kg before the start of the study, at
the end of the baseline phase, and at the end of the intervention phase was not normally distributed based on z-scores less than 3.2 for skew and kurtosis. Thus, we used a square-root transformation for these data. This transformation did not affect the outcome of subsequent statistical analyses, so those data are not reported here. Before the start of the study participants in the CM group had an average weight of 76.05 kg (SD = 17.03, median = 73.1, range = 63), following the baseline phase participants had an average weight of 76.09 kg (SD = 17.51, median = 73.4, range = 64), and following intervention participants in the CM group had an average weight of 76.19 kg (SD = 17.99, median = 73.4, range = 65). Before the start of the study participants in the PBI group had an average weight of 89.31 kg (SD = 28.91, median = 78, range = 79), following the baseline phase participants group had an average weight of 89.17 kg (SD = 28.64, median = 79, range = 79), and following intervention participants in the PBI group had an average weight of 90.53 kg (SD = 29.33, median = 78.4, range = 79). Before the start of the study participants in the SM group had an average weight of 77.66 kg (SD = 18.7, median = 75.3, range = 73), following the baseline phase participants had an average weight of 77.66 kg (SD = 19.06, median = 74.4, range = 74), and following intervention they had an average weight of 77.61 kg (SD = 18.89, median = 73.5, range = 72).

We conducted a 3 (group) by 3 (time) mixed factorial ANCOVA with race/ethnicity as a covariate to compare the main effects of group and time, as well as the interactions between group and time on average weight. Two participants (both in the PBI group) were excluded from the analysis because there were no weight data collected (i.e., the final appointment occurred greater than three months from the last day of intervention). There was no significant main effect of time on average weight, $F(2, 66) = .2, p = .82, \eta^2 = .01$. There was also no main effect of group, $F(2, 33) = 1.84, p = .18, \eta^2 = .1$ on average weight. There were no significant
increases of time and race/ethnicity, $F(2, 66) = .27, p = .76, \eta^2_p = .01$ and time and group, $F(4, 66) = 1.19, p = .32, \eta^2_p = .07$ on average weight.

Figure 15 displays the average percent change in weight between pre-baseline and post-intervention measurements. Table 3 shows the means, ranges, and standard errors for the average percent change in average weight for each group. Participants in the CM and SM groups, on average, experienced a small decrease in weight (.02% $[SEM = .59\%]$ and .09% $[SEM = .53\%]$, respectively), while participants in the PBI group, on average, experienced a 1.48% $[SEM = .93\%]$ increase in weight. We conducted a one-way ANOVA to compare the average percent change in weight between pre-baseline and post-intervention measurements across groups, and there were no significant differences, $F(2, 36) = 1.61, p = .22, \eta^2_p = .08$.

**Discussion**

In the United States, physical inactivity poses a major public health problem. There are several negative health implications related to lack of physical activity, such as obesity (Jensen et al., 2013), increased risk of noncommunicable diseases (e.g., stroke, cancer, and type 2 diabetes; Jensen et al., 2013; Lee et al., 2012), and increased risk of premature death (Lee et al.). In addition, physical inactivity also has negative economic implications. The estimated average cost of physical inactivity in the United States is approximately $251 billion per year (Chenoweth & Leutzinger, 2006), with worker’s compensation, disability leave, and direct medical care (Kruk, 2014; Pratt et al., 2000) being three contributors to that cost. Given the negative impact of physical inactivity on the overall well-being of people in the United States, the development of large-scale interventions to increase physical activity is crucial. It is unlikely that researchers will be able to develop a “one-size-fits-all” intervention; however, it is essential that researchers
continue to investigate and develop methods that can promote increases in physical activity for the majority of people.

The current study attempted to investigate an incentive-based intervention to increase adults’ physical activity over a two-month period. Specifically, we evaluated whether a lottery-based contingency-management intervention using financial incentives would increase average daily calorie expenditure. Additionally, we compared the effects of lottery-based contingency management to assured financial compensation (i.e., participation-based incentives) and self-monitoring. We did not find any significant differences in average daily calorie expenditure between groups across time, nor did we find any significant differences within groups across time (i.e., between baseline and intervention). We also evaluated outcomes related to average daily steps, average daily active min, average time spent in each activity zone per day, average resting heart rate, and average weight, and we did not find any significant differences between or within groups using these metrics. Thus, the lottery-based contingency-management intervention did not increase participants’ physical activity.

Currently, there is considerable variability in the literature regarding the efficacy of behavioral physical activity interventions. The results of the current study are inconsistent with a number of studies that have been successful at increasing physical activity in adults (e.g., Adams et al., 2017; Donaldson & Normand, 2009; Donlin Washington et al., 2014). However, there are some studies that, as is the case with the current study, have not been successful at increasing adults’ physical activity (e.g., Burns & Rothman, 2018; Hunter et al., 2013). There appear to be some differences across studies on physical activity such as a) the diversity of the sample, b) the selection of dependent variables and how they are measured, and c) the duration of the interventions. To make progress towards developing successful, large-scale interventions to
increase physical activity, researchers should investigate these potential sources of variation and determine how they may influence physical activity data.

**Demographics**

In the literature on interventions for physical activity, there appears to be a lack of standard reporting practices and diversity of participant demographic characteristics. These variables may be meaningful for the analysis and interpretation of physical activity data, which in turn may have implications for the widespread application of physical activity interventions to improve national and global health. Currently, a number of studies do not report race (e.g., Andrade et al., 2014; Cohen, Chelland, Ball, & LeMura, 2002; Cohen et al., 2007; Donlin Washington et al. 2014; Fennell et al., 2016), and those that do, reported that the majority of their participants were White (e.g., Burns & Rothman, 2018; Kurti & Dallery, 2013; Losina et al., 2017). Additionally, high percentages of female participants are commonly reported in the experimental literature (e.g., Adams et al., 2017; Burns & Rothman; Donlin Washington et al., 2016; Kurti & Dallery; Losina et al.; Nishiwaki, Kuriyama, Ikegami, Nakashima, & Matsumoto, 2014). Overall, there appears to be an overrepresentation of White females in physical activity research, which limits the extent to which the results of previous studies can be generalized to larger populations.

In the current study, the demographic characteristics of participants were similar to those of previous studies; however, the sample was not completely homogenous. In our sample, 20.51% of participants reported being nonwhite, but the representation of different races and ethnicities was not equally distributed across groups. Specifically, in the CM group, 84.62% of participants were White and 15.38% were Asian; in the PBI group 53.85% of participants were White, 23.08% were Asian, 15.38% were African American, and 7.69% were African, and in the
SM group 92.31% of participants were White, and 7.69% were Asian. The majority of participants enrolled in the current study were female (74.36%). Our results suggest that race/ethnicity (the covariate) influenced average resting heart rate and average daily calorie expenditure; though the extent remains unclear. There is some evidence to suggest that there are differences in resting heart rate variability across races/ethnicities (e.g., Hill et al., 2015). In the future, researchers should determine if and in what ways demographic characteristics like race/ethnicity, gender, and sex influence changes in physical activity. Researchers should take steps to recruit diverse samples (where race/ethnicity, gender, and sex are equally distributed) and report the demographic data of their participants. These efforts may help pinpoint underrepresented groups of participants, highlight other variables that may influence physical activity, and inform large-scale, targeted interventions to increase physical activity for the largest number of people.

**Dependent Variables and Data Collection**

The degree of inconsistency with the selection and measurement of dependent variables across studies is notable. To date, there are a variety of metrics (i.e., dependent variables) used to indicate changes in physical activity, such as step count (e.g., Adams et al., 2017; Andrade et al., 2014; Burns & Rothman, 2018; Chapman, Colby, Convery, & Coups, 2015; Donlin Washington et al., 2014; Donlin Washington et al., 2016; Kurti & Dallery, 2013; Van Wormer, 2004), calorie expenditure (e.g., Donaldson & Normand, 2009), distance walked or run (e.g., Krentz, Miltenberger, & Valbuena, 2016; Wack et al. 2014), heart rate (e.g., Eckard, Kuwabara, & Van Camp, 2019), and weight (e.g., Mann, 1972). Although it may be beneficial for researchers to have a variety of metrics of physical activity to measure in their interventions, it is possible that each metric calculates and shows changes in physical activity differently. For example, time
spent engaging in physical activity (e.g., daily active min) may demonstrate increases in average amount of physical activity, while heart rate (e.g., decreases in average resting heart rate) may indicate increases in quality of physical activity. The most commonly selected dependent variable in physical activity interventions is daily step count; however, there is no evidence to suggest whether steps, or any other metric, is the most appropriate for measuring changes in physical activity.

In addition to the lack of evidence on which metric is the most appropriate for measuring changes in physical activity during a large-scale intervention, the method by which those data are collected and interpreted remains inconsistent across studies. The measurement tools and methods that are used to measure changes in physical activity can influence how those activity data are displayed and interpreted. Changes in daily step-count data may be more noticeable compared to changes in daily calorie expenditure. For example, a 1,000-step increase may be judged as a clinically significant improvement (considering the common goal of 10,000 steps per day), whereas those 1,000 steps may only burn an extra 40 calories, which may not be judged as clinically significant. Discrepancies between the analysis and interpretation of physical activity intervention data across studies can deter the development of successful, large-scale physical activity interventions. Thus, it is important for researchers to continue investigating the use of different tools to measure physical activity data and to consider how those data are displayed and analyzed.

There is a need to identify cost-effective, accurate, and practical means for measuring physical activity during participants’ daily life. Some of the tools that can be used to measure metrics of physical activity include pedometers, accelerometers, and heart-rate monitors. In the literature, there is variability in the tools that are used to measure physical activity; although, it is
commonly reported that Fitbit devices and other similar wrist-based fitness tracking devices are used. Research suggests that devices like Fitbits are sufficient in measuring physical activity (e.g., Evenson et al., 2015). Furthermore, Fitbits may be practical data collection tools for large-scale interventions because they are small, can be worn easily and for long periods of time, can be budget-friendly, and there is high inter-device reliability across the different Fitbit devices (Van Camp & Hayes, 2017), as well as high accuracy and reliability between Fitbits and other commercial devices (de Mann et al., 2016).

Fitbits and other electronic devices afford feasible methods for researchers to obtain up-to-date or real-time data. For example, they can be used to collect data remotely (i.e., automatically syncing to technology, like smartphone applications). Electronic data collection can be used alone or in combination with self-report methods (e.g., Donaldson & Normand, 2009). Measurement methods like remote/electronic and self-report have their own advantages and disadvantages; however, these remain unclear, as little research has been done comparing the two. In the current study, a possible advantage of using remote, electronic data collection was that, compared to self-report methods, participants may have been less likely to falsify or misreport their data, making the current data more believable (however, this method is not without its limitations as it is possible that any participant could have had another person wear the Fitbit during the study).

Despite the advantage of increased believability of the data, a potential disadvantage was that automatically syncing the electronic data does not require participants to attend to their data, which introduces the potential limitation that participants did not regularly self-monitor their progress. Some research (e.g., Gleeson-Krieg, 2006; Turner-McGrievy et al., 2013) suggests that self-monitoring is a necessary component of physical activity interventions. One way to ensure
INCREASING PHYSICAL ACTIVITY

participants regularly interact with the data produced by the device would be to have some regular contact from personnel. For example, an email or some other regular check-in from study personnel may prompt a participant to check the data produced by the device (e.g., Fitbit). This type of contact may have played a role in the current study, as participants in the CM group received daily feedback from the experimenter and participants in the PBI group received an emailed gift card once per week. Results from the time series forecast predict that the average number of calories expended per day would have increased across weeks for individuals in the PBI group (where participants were contacted by study personnel once per week) if the study had continued for another eight weeks, suggesting that regular contact from study personnel may be an essential component of physical activity interventions. However, little work has been done on individual intervention components and how they contribute to large-scale intervention packages. In fact, for researchers to develop useful, large-scale physical activity interventions, they must be able to make evidence-based decisions on the most appropriate metric(s) of physical activity, data collection tools, and data collection techniques, as well as intervention components.

**Duration of Interventions and Maintenance**

In the literature, the optimal duration of physical activity interventions has not been established. Intervention durations range from approximately three weeks (Donlin Washington et al., 2014; Wysocki et al., 1979) to one year (Jeffrey, Thorson, Wing, & Burton, 1998). Shorter studies like Wysocki et al. and Donlin Washington and colleagues report that their interventions effectively increased physical activity. However, with those studies lasting only a few weeks, we know little about the long-term effects of these interventions on physical activity. Short-duration studies, although often successful at increasing physical activity, may not accurately represent
physical activity levels that maintain over a long period time. For example, depending on when the study was conducted, variables like holidays, weather events, and illnesses may not be captured in short-term interventions. It is possible that if those same interventions had been carried out longer, physical activity may have decreased.

On the other hand, long-duration interventions may capture information about variables in a person’s natural environment that are likely to control physical activity, however there are mixed results on their effectiveness for increasing physical activity. Some studies, like Jeffrey et al. (1998) and Adams et al. (2017) have successfully increased physical activity using their interventions, while others (e.g., Burns & Rothman, 2018) have failed to increase physical activity. We still do not know if longer interventions (i.e., greater than one year) would be more or less successful at increasing physical activity, and whether we would see continued increases over a long period of time. Additionally, there is a lack of research on maintenance of physical activity, regardless of intervention length. To prevent further increases in the prevalence of death, disease, and obesity, it is essential for researchers to evaluate how to promote increases in physical activity over longer periods of time, as well as maintenance.

**Strengths and Limitations**

Despite notable strengths of the study, such as the use of an objective data-collection tool and a compliant sample of participants (i.e., only five participants did not wear and/or charge their Fitbit on three or less occasions), overall, the results of the current study show that an eight-week, lottery-based contingency management intervention using financial incentives failed to promote increased physical activity in healthy adults. Although the intervention components as arranged in the current study were ineffective, they have some support established by previous research, and future investigations on these techniques are warranted. Further investigations into
The current study unsuccessfully used percentile schedules for setting calorie-expenditure goals. Although we used calorie-expenditure goals to include a wider variety of physical, it is possible that goals based on another metric, specifically steps, would have yielded different results. It is possible that daily step count goals would have been less aversive and more consumable to participants because they are able to more easily see and quantify changes in their step count over the course of the day. For example, someone who took 25 steps knows that they can add 25 steps to their existing count, whereas they would need to guess at how many calories those 25 steps burned. As stated previously, it is crucial that researchers continue to investigate the most appropriate metric of physical activity and how goals should be set using that metric.

To set our participants’ calorie-expenditure goals, we used a percentile schedule using the 70th percentile criterion. While we failed to increase physical activity, previous research suggests that the use of percentile (i.e., 70th percentile) schedules is valid for changing behavior (Galbicka, 1994), and more specifically, physical activity (e.g., Adams et al., 2017; Donlin Washington et al., 2014; Kurti & Dallery, 2013). In the current study, the percentile schedule arrangement was not typical compared to previous research that has used percentile schedules to change behavior (e.g., Athens, Vollmer, & St. Peter Pipkin, 2007; Galbicka, 1994). Specifically, in a typical percentile arrangement, the index value changes each day instead of changing every four days (as was the case in the current study), and goals decreased to previously used values in the current study, instead of resetting, like in typical percentile arrangements. It is possible that, had we used a more typical percentile schedule arrangement, calorie-expenditure goals would have increased gradually, thus increasing the likelihood that participants would meet them and
INCREASING PHYSICAL ACTIVITY

contact the contingency in place. Additionally, if we reset the schedule in situations where a
given participant’s goal needed to be decreased, it is possible that they would have met more of
their goals.

Although it was not useful during the intervention in the current study, it is still possible
that the use of percentile schedules (e.g., 70th percentile criterion) are sufficient for increasing
physical activity. A possible explanation for why the percentile schedule in the current study was
ineffective is that the calorie-expenditure goals for each day were too high for participants to
achieve. Calorie-expenditure goals that were too high may have diminished the likelihood that
participants would exercise in order to meet them. On the other hand, it is possible that the
calorie-expenditure goals were not sensitive enough to produce clinically and statistically
significant increases in physical activity. If a participant burned a similar number of calories
across 14 days, (e.g., they burned between 2,500 and 2,700 calories per day during the previous
2 weeks) it is likely that their next goal would be similar to the previous goal (e.g., the first goal
might have been 2,501 and the new goal might be 2,567). Based on the methods of percentile
schedules, the participant has been successful (as evidenced by the increased goal). However,
these data would not represent clinically or statically significant change. The possible lack of
sensitivity of the method we used to set calorie-expenditure goals was a limitation to the current
study. Future researchers may be able to shed more light on the use of percentile schedules for
setting physical activity goals by evaluating and comparing different criteria and schedule
arrangements.

In addition to goal setting with percentile schedules, our failed intervention included
contingency management. There are many studies (e.g., Andrade et al., 2014; Donlin
Washington et al., 2014; Mann, 1972; Meredith et al., 2011; Petry et al., 2010; Wysocki et al.,
INCREASING PHYSICAL ACTIVITY

A potential limitation to the current study was that some participants in the CM group may not have contacted the incentive enough. The probability of winning a gift card every week was directly related to the number of days on which participants met their calorie-expenditure goals. So, those participants whose goals were too high may not have had many chances to win a gift card at the end of a given week. On the other hand, some participants may have contacted the incentive frequently due to luck of the draw, despite having met their goals only a handful of times, which may have reinforced a lack of physical activity or current physical activity levels.

Two participants in the CM group met their goal on at least 50% of days, one of whom earned 6 gift cards and the other earned all 8. Table 10 shows the number of intervention days on which participants in the CM group met their calorie-expenditure goals and the number of gift cards they earned. Figure 16 depicts the results of a two-tailed Pearson’s bivariate correlation between the number of days on which goals were met and the number of gift cards earned. The number of days on which goals were met ($M = 20, SD = 5.35$) was positively correlated with the number of gift cards earned ($M = 5.46, SD = 1.33$), $r = .69, p = .009, R^2 = .48$.

Relationally, we used financial incentives in the form of Amazon gift cards as the tangible reinforcement component of our contingency management intervention. In the CM group, participants were able to earn $5 gift cards from a lottery contingent on the number of days on which they met their calorie-expenditure goals, and participants in the PBI group received a $5 gift card each week. The use of small financial incentives may have been a limitation to the current study, as we were unsuccessful at increasing physical activity; however, previous research has successfully used financial incentives and contingency management to promote healthy behavior, (e.g., drug abstinence; Jones, Haug, Silverman, Stitzer, & Svikis, 2001; Stitzer
& Vandrey, 2008), which suggests that we likely had issues with the magnitude of our reinforcer (i.e., we were not paying our participants enough). In fact, drug-abuse research suggests that greater monetary amounts are most effective for promoting behavior change in a contingency-management intervention (e.g., Stoops, Life, & Rush, 2010), however, dollar amounts of around $15 have been effective (e.g., Kropp et al., 2017; Rash, Stitzer, & Weinstock, 2017). While the idea that more money would equal more behavior-change makes logical sense, there is no evidence to support this claim in the physical activity literature base. Researchers should investigate the most effective monetary value(s) for promoting physical activity, in order to continue to inform effective, large-scale interventions.

Conclusion

As made evident by the results of the current study and previous physical activity research, physical activity-related behavior (e.g., calories, steps, etc.) is difficult to change. Despite the knowledge that percentile schedules and contingency management are powerful behavior-change techniques, much is still unknown about how best to develop practical, large-scale physical activity interventions. Furthermore, disparities in demographic characteristics may mask information about the extent to which large-scale interventions can increase physical activity behavior for large, diverse groups of people (e.g., the population of the United States). Additionally, there is substantial variability in how physical interventions are designed. Researchers should focus their efforts on providing support for the use of different metrics of physical activity, how those metrics are measured, and for how long interventions need to be in place. If there continues to be inconsistencies across physical activity interventions in the literature, and the results of those interventions continue to be heavily mixed, it is unlikely that we will be able to reverse the negative impacts of disease and obesity. Thus, it is possible that the
INCREASING PHYSICAL ACTIVITY

health of the United States relies (at least partially) on researchers’ ability to develop interventions to reduce physical inactivity and the negative health and economic costs associated with it.
References


INCREASING PHYSICAL ACTIVITY


Meredith, S. E., Grabinski, M. J., & Dallery, J. (2011). Internet-based group contingency management to promote abstinence from cigarette smoking: A feasibility study. *Drug...


Table 1

Demographic information for participants in the CM, PBI, and SM groups

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<td></td>
</tr>
<tr>
<td>Average Age</td>
<td>25.69</td>
<td>28.69</td>
<td>25.38</td>
</tr>
<tr>
<td>Range</td>
<td>18-46</td>
<td>19-55</td>
<td>19-36</td>
</tr>
<tr>
<td><strong>Race/Ethnicity</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% White</td>
<td>84.62</td>
<td>53.85</td>
<td>92.31</td>
</tr>
<tr>
<td>% Asian</td>
<td>15.38</td>
<td>23.08</td>
<td>7.69</td>
</tr>
<tr>
<td>% African American</td>
<td>0</td>
<td>15.38</td>
<td>0</td>
</tr>
<tr>
<td>% African</td>
<td>0</td>
<td>7.69</td>
<td>0</td>
</tr>
<tr>
<td><strong>Highest Level of Education</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% Some High School</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>% High School Diploma</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>% Some College</td>
<td>53.85</td>
<td>53.85</td>
<td>46.15</td>
</tr>
<tr>
<td>% Associate's</td>
<td>0</td>
<td>7.69</td>
<td>0</td>
</tr>
<tr>
<td>% Bachelor's</td>
<td>30.8</td>
<td>23.08</td>
<td>30.8</td>
</tr>
<tr>
<td>% Master's</td>
<td>15.38</td>
<td>15.38</td>
<td>23.08</td>
</tr>
<tr>
<td>% Doctorate</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

*Note:* No values reported in the table are statistically significant.
Table 2

*Descriptive statistics for the average number of calories expended per day, the average number of steps taken per day, and the average number of active min per day for the CM, PBI, and SM groups*

<table>
<thead>
<tr>
<th></th>
<th>Contingency Management</th>
<th>Participation-Based Incentive</th>
<th>Self-Monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calories Burned - Baseline</td>
<td>M (SD) 2319.15 (457.67)</td>
<td>2454.23 (639.74)</td>
<td>2473.38 (571.18)</td>
</tr>
<tr>
<td></td>
<td>Range 1782 - 3585</td>
<td>1547 - 3622</td>
<td>1704 - 3591</td>
</tr>
<tr>
<td>Calories Burned - Intervention</td>
<td>M (SD) 2395.38 (458.84)</td>
<td>2489.15 (637.32)</td>
<td>2417.54 (504.31)</td>
</tr>
<tr>
<td></td>
<td>Range 2036 - 3566</td>
<td>1589 - 3752</td>
<td>1651 - 3562</td>
</tr>
<tr>
<td>Steps Taken - Baseline</td>
<td>M (SD) 7283.38 (2243.35)</td>
<td>6112.46 (1646.92)</td>
<td>7289.62 (1773.07)</td>
</tr>
<tr>
<td></td>
<td>Range 2418 - 10163</td>
<td>2845 - 8177</td>
<td>4794 - 10347</td>
</tr>
<tr>
<td>Steps Taken - Intervention</td>
<td>M (SD) 8322.69 (1928.54)</td>
<td>6433.62 (1356.94)</td>
<td>7206.15 (1777.31)</td>
</tr>
<tr>
<td></td>
<td>Range 4729 - 11475</td>
<td>4705 - 9919</td>
<td>4967 - 10532</td>
</tr>
<tr>
<td>Active Min - Baseline</td>
<td>M (SD) 25.31 (17)</td>
<td>15.85 (9.34)</td>
<td>28.38 (19.55)</td>
</tr>
<tr>
<td></td>
<td>Median 22</td>
<td>17</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Range 8 - 71</td>
<td>1 - 32</td>
<td>5 - 71</td>
</tr>
<tr>
<td>Active Min - Intervention</td>
<td>M (SD) 28.85 (15.33)</td>
<td>20.85 (11.47)</td>
<td>26.85 (22.54)</td>
</tr>
<tr>
<td></td>
<td>Median 24</td>
<td>19</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Range 7 - 62</td>
<td>6 - 45</td>
<td>5 - 76</td>
</tr>
</tbody>
</table>

*Note:* No values reported in the table are statistically significant.
Table 3

The average percent change in the average number of calories expended per day, the average number of steps taken per day, average resting heart rate, and average weight between baseline and intervention for the CM, PBI, and SM groups

<table>
<thead>
<tr>
<th></th>
<th>Contingency Management</th>
<th>Participation-Based Incentive</th>
<th>Self-Monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Change Calories</td>
<td>3.51 (1.48)</td>
<td>1.78 (2.02)</td>
<td>-1.47 (2.33)</td>
</tr>
<tr>
<td></td>
<td>-3.83 - 17.4</td>
<td>-9.08 - 15.02</td>
<td>-12.62 - 14.94</td>
</tr>
<tr>
<td>% Change Steps</td>
<td>21.49 (8.59)</td>
<td>10.68 (7.54)</td>
<td>21.19 (23.62)</td>
</tr>
<tr>
<td></td>
<td>-17.71 - 101.03</td>
<td>-28.88 - 65.45</td>
<td>-42.85 - 284.69</td>
</tr>
<tr>
<td>% Change Resting HR (BPM)</td>
<td>7.9 (3.13)</td>
<td>3.68 (2.75)</td>
<td>17.42 (6.84)</td>
</tr>
<tr>
<td></td>
<td>-9.2 - 31.88</td>
<td>-12.12 - 14.47</td>
<td>-11.11 - 72.31</td>
</tr>
<tr>
<td>% Change Weight (kg)</td>
<td>-.02 (.59)</td>
<td>1.48 (.93)</td>
<td>-.09 (.53)</td>
</tr>
<tr>
<td></td>
<td>-4.78 - 2.15</td>
<td>-2.46 - 7.23</td>
<td>-3.09 - 3.38</td>
</tr>
</tbody>
</table>

Note: No values reported in the table are statistically significant.
Table 4

The average percent of days where participants in the CM group expended a greater number of calories per day during intervention compared to the average number of calories expended per day during the entire baseline phase.

<table>
<thead>
<tr>
<th></th>
<th>Contingency Management</th>
<th>Participation-Based Incentive</th>
<th>Self-Monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average % Days</td>
<td>M (SEM)</td>
<td>54.76 (3.65)</td>
<td>49.62 (5.11)</td>
</tr>
<tr>
<td>Range</td>
<td></td>
<td>35.71 - 76.79</td>
<td>21.82 - 79.25</td>
</tr>
</tbody>
</table>

Note: No values reported in the table are statistically significant.
Table 5

*The average percent of days where participants in the CM group expended a greater number of calories per day during intervention compared to the average number of calories expended per day for the last six days of the baseline phase*

<table>
<thead>
<tr>
<th></th>
<th>Contingency Management</th>
<th>Participation-Based Incentive</th>
<th>Self-Monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average % Days M (SEM)</td>
<td>59.8 (5.09)</td>
<td>50.75 (6.63)</td>
<td>46.37 (7.62)</td>
</tr>
<tr>
<td>Range</td>
<td>28.57 - 92.86</td>
<td>3.64 - 81.13</td>
<td>1.79 - 78.57</td>
</tr>
</tbody>
</table>

*Note:* No values reported in the table are statistically significant.
Average differences in the average number of active min per day and the average number of min spent in the Fat Burn, Cardio, and Peak activity zones for the CM, PBI, and SM groups

<table>
<thead>
<tr>
<th></th>
<th>Contingency Management</th>
<th>Participation-Based Incentive</th>
<th>Self-Monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Difference in</td>
<td>M (SEM)</td>
<td>3.54 (2.73)</td>
<td>5 (2.89)</td>
</tr>
<tr>
<td>Active Min</td>
<td>Range</td>
<td>-18 - 16</td>
<td>-10 - 20</td>
</tr>
<tr>
<td>Average Difference in</td>
<td>M (SEM)</td>
<td>8 (19.73)</td>
<td>25.08 (17.4)</td>
</tr>
<tr>
<td>Fat Burn Activity Zone Min</td>
<td>Range</td>
<td>-72 - 199</td>
<td>-51 - 181</td>
</tr>
<tr>
<td>Average Difference in</td>
<td>M (SEM)</td>
<td>2.08 (1.15)</td>
<td>1.31 (.72)</td>
</tr>
<tr>
<td>Cardio Activity Zone Min</td>
<td>Range</td>
<td>-5 - 12</td>
<td>-2 - 8</td>
</tr>
<tr>
<td>Average Difference in</td>
<td>M (SEM)</td>
<td>.08 (.31)</td>
<td>.15 (.10)</td>
</tr>
<tr>
<td>Peak Activity Zone Min</td>
<td>Range</td>
<td>-3 - 1</td>
<td>0 - 1</td>
</tr>
</tbody>
</table>

*Note: No values reported in the table are statistically significant.*
Table 7

*Descriptive statistics for the average number of min spent in the Fat Burn, Cardio, and Peak activity zones for the CM, PBI, and SM groups*

<table>
<thead>
<tr>
<th>Activity Zone</th>
<th>Contingency Management</th>
<th>Participation-Based Incentive</th>
<th>Self-Monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M (SD)</td>
<td>256.46 (161.71)</td>
<td>207 (236.26)</td>
</tr>
<tr>
<td></td>
<td>Median</td>
<td>248</td>
<td>134</td>
</tr>
<tr>
<td></td>
<td>Range</td>
<td>44 - 581</td>
<td>31 - 942</td>
</tr>
<tr>
<td>Fat Burn Zone - Baseline</td>
<td>M (SD)</td>
<td>264.46 (183.81)</td>
<td>232.08 (225.66)</td>
</tr>
<tr>
<td></td>
<td>Median</td>
<td>253</td>
<td>178</td>
</tr>
<tr>
<td></td>
<td>Range</td>
<td>52 - 627</td>
<td>21 - 907</td>
</tr>
<tr>
<td>Fat Burn Zone - Intervention</td>
<td>M (SD)</td>
<td>3.46 (4.89)</td>
<td>3.23 (5.48)</td>
</tr>
<tr>
<td></td>
<td>Median</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Range</td>
<td>0 - 18</td>
<td>0 - 17</td>
</tr>
<tr>
<td>Cardio Zone - Baseline</td>
<td>M (SD)</td>
<td>5.54 (7.88)</td>
<td>4.54 (7.46)</td>
</tr>
<tr>
<td></td>
<td>Median</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Range</td>
<td>0 - 30</td>
<td>0 - 25</td>
</tr>
<tr>
<td>Cardio Zone - Intervention</td>
<td>M (SD)</td>
<td>.46 (.88)</td>
<td>.08 (.28)</td>
</tr>
<tr>
<td></td>
<td>Median</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Range</td>
<td>0 - 3</td>
<td>0 - 1</td>
</tr>
<tr>
<td>Peak Zone - Baseline</td>
<td>M (SD)</td>
<td>.54 (.78)</td>
<td>.23 (.44)</td>
</tr>
<tr>
<td></td>
<td>Median</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Range</td>
<td>0 - 2</td>
<td>0 - 1</td>
</tr>
<tr>
<td>Peak Zone - Intervention</td>
<td>M (SD)</td>
<td>.46 (.88)</td>
<td>.08 (.28)</td>
</tr>
<tr>
<td></td>
<td>Median</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Range</td>
<td>0 - 3</td>
<td>0 - 1</td>
</tr>
</tbody>
</table>

*Note:* No values reported in the table are statistically significant.
Table 8

Descriptive statistics for average resting heart rate at the start of the study, following the baseline phase, and post-intervention for the CM, PBI, and SM groups

<table>
<thead>
<tr>
<th></th>
<th>Contingency Management</th>
<th>Participation-Based Incentive</th>
<th>Self-Monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Resting HR at</td>
<td>M (SD)</td>
<td>80.27 (9.92)</td>
<td>72.38 (11.60)</td>
</tr>
<tr>
<td>Start (BPM)</td>
<td>Range</td>
<td>64 - 97</td>
<td>66 - 101</td>
</tr>
<tr>
<td>Average Resting HR</td>
<td>M (SD)</td>
<td>82.55 (11.93)</td>
<td>78.15 (12.97)</td>
</tr>
<tr>
<td>Post-Baseline (BPM)</td>
<td>Range</td>
<td>66 - 105</td>
<td>59 - 101</td>
</tr>
<tr>
<td>Average Resting HR</td>
<td>M (SD)</td>
<td>83.55 (14.22)</td>
<td>84.85 (21.24)</td>
</tr>
<tr>
<td>Post-Intervention (BPM)</td>
<td>Range</td>
<td>70 - 109</td>
<td>58 - 101</td>
</tr>
</tbody>
</table>

Note: There were statistically significant differences in average resting heart rate between pre- and post-baseline measurements and between pre-baseline and post-intervention measurements for all groups.
Table 9

**Descriptive statistics for average weight at the start of the study, following the baseline phase, and post-intervention for the CM, PBI, and SM groups**

<table>
<thead>
<tr>
<th></th>
<th>Contingency Management</th>
<th>Participation-Based Incentive</th>
<th>Self-Monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Average Weight at Start (kg)</strong></td>
<td>M (SD) 76.05 (17.03)</td>
<td>89.31 (28.91)</td>
<td>77.66 (17.70)</td>
</tr>
<tr>
<td></td>
<td>Median 73.1</td>
<td>78</td>
<td>75.3</td>
</tr>
<tr>
<td></td>
<td>Range 61 - 124</td>
<td>73 - 152</td>
<td>48 - 121</td>
</tr>
<tr>
<td><strong>Average Weight Post-Baseline (kg)</strong></td>
<td>M (SD) 76.09 (17.51)</td>
<td>89.17 (28.64)</td>
<td>77.66 (19.06)</td>
</tr>
<tr>
<td></td>
<td>Median 73.4</td>
<td>79</td>
<td>74.4</td>
</tr>
<tr>
<td></td>
<td>Range 60 - 125</td>
<td>71 - 150</td>
<td>49 - 123</td>
</tr>
<tr>
<td><strong>Average Weight Post-Intervention (kg)</strong></td>
<td>M (SD) 76.19 (17.99)</td>
<td>90.53 (29.33)</td>
<td>77.61 (18.89)</td>
</tr>
<tr>
<td></td>
<td>Median 73.4</td>
<td>78.4</td>
<td>73.5</td>
</tr>
<tr>
<td></td>
<td>Range 61 - 126</td>
<td>74 - 153</td>
<td>49 - 121</td>
</tr>
</tbody>
</table>

*Note:* No values reported in the table are statistically significant.
Table 10

*The average percent of days during intervention on which participants in the CM group met their calorie-expenditure goals and the number of gift cards they earned*

<table>
<thead>
<tr>
<th>Participant</th>
<th># Days Goal Met (%)</th>
<th># Gift Cards Received (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>014</td>
<td>29 (51.79)</td>
<td>8 (100)</td>
</tr>
<tr>
<td>742</td>
<td>28 (50)</td>
<td>6 (75)</td>
</tr>
<tr>
<td>949</td>
<td>26 (46.43)</td>
<td>6 (75)</td>
</tr>
<tr>
<td>360</td>
<td>22 (39.29)</td>
<td>5 (62.5)</td>
</tr>
<tr>
<td>548</td>
<td>22 (39.29)</td>
<td>5 (62.5)</td>
</tr>
<tr>
<td>190</td>
<td>20 (35.71)</td>
<td>7 (87.5)</td>
</tr>
<tr>
<td>019</td>
<td>20 (35.71)</td>
<td>7 (87.5)</td>
</tr>
<tr>
<td>030</td>
<td>18 (32.14)</td>
<td>4 (50)</td>
</tr>
<tr>
<td>050</td>
<td>18 (32.14)</td>
<td>6 (75)</td>
</tr>
<tr>
<td>061</td>
<td>16 (28.57)</td>
<td>4 (50)</td>
</tr>
<tr>
<td>149</td>
<td>15 (26.79)</td>
<td>4 (50)</td>
</tr>
<tr>
<td>049</td>
<td>15 (26.79)</td>
<td>5 (62.5)</td>
</tr>
<tr>
<td>702</td>
<td>11 (19.64)</td>
<td>4 (50)</td>
</tr>
</tbody>
</table>

*Note: The number of day on which a calorie-expenditure goal was met was positively correlated with the number of gift cards received*
Figure 1. The average number of calories expended in the baseline and intervention phases for the contingency management group, participation-based incentive, and self-monitoring groups. The error bars represent standard error of the mean.
Figure 2. The average percent change in the average number of calories expended per day between baseline and intervention for the contingency management, participation-based incentive, and self-monitoring groups. The error bars represent standard error of the mean.
Figure 3. The average percent of days for which the number of calories expended per day during intervention exceeded the average number of calories expended per day during the entire baseline phase for the contingency management, participation-based incentive, and self-monitoring groups. The error bars represent standard error of the mean.
Figure 4. The average percent of days for which the number of calories expended per day exceeded the average number of calories expended per day during the last 6 days of baseline for the contingency management, participation-based incentive, and self-monitoring groups. The error bars represent standard error of the mean.
**Figure 5.** Time series analysis and forecast for the average number of calories expended per day across weeks for the contingency management, participation-based incentive, and self-monitoring groups. The error bars represent standard error of the mean.
**Figure 6.** The average number of steps taken per day during the baseline and intervention phases for the contingency management, participation-based incentive, and self-monitoring groups. The error bars present standard error of the mean.
Figure 7. The average percent change in the average number of steps taken per day between baseline and intervention for the contingency management, participation-based incentive, and self-monitoring groups. The error bars represent standard error of the mean.
Figure 8. The average number of active min per day during the baseline and intervention phases for the contingency management, participation-based incentive, and self-monitoring groups. The error bars represent standard error of the mean.
**Figure 9.** The average difference in the average number of active min per day between baseline and intervention for the contingency management, participation-based incentive, and self-monitoring groups. The error bars represent standard error of the mean.
Figure 10. The average number of min spent in the Fat Burn activity zone per day between baseline and intervention for the contingency management, participation-based incentive, and self-monitoring groups. The error bars represent standard error of the mean.
Figure 11. The average number of min spent in the Cardio activity zone per day between baseline and intervention for the contingency management, participation-based incentive, and self-monitoring groups. The error bars represent standard error of the mean.
**Figure 12.** The average number of min spent in the Peak activity zone per day between baseline and intervention for the contingency management, participation-based incentive, and self-monitoring groups. The error bars represent standard error of the mean.
Figure 13. The average differences in the average number of min spent in the Fat Burn, Cardio, and Peak activity zones per day between baseline and intervention for the contingency management, participation-based incentive, and self-monitoring groups. The error bars represent standard error of the mean.
Figure 14. The average percent change increase in average resting heart rate between pre-baseline and post-intervention measurements for the contingency management, participation-based incentive, and self-monitoring groups. The error bars represent standard error of the mean.
Figure 15. The average percent change in average weight between pre-baseline and post-intervention measurements for the contingency management, participation-based incentive, and self-monitoring groups. The error bars represent standard error of the mean.
Figure 16. Positive correlation between the number of days participants in the Contingency Management group met their goals and the number of gift cards they earned.
### Appendix A

Questionnaire

*For research staff:*
- Participant ID: ___________  
- Date: ___________  
- Time: ___________
- RA name: ____________________________________

How old are you? __________

What is your gender? ____________________________________

What is your ethnicity? ____________________________________

What is your highest level of education? (check the one that best applied to you)
- o Some high school
- o High school Diploma
- o Some College
- o Associate’s
- o Bachelor’s
- o Master’s
- o Doctorate

What is your employment status?
- o Student
- o Employed – Full-time
- o Employed – Part-time
- o Unemployed
- o Military
- o Retired

Are you, or is there a chance that you may be, pregnant?  
YES  NO

Do you own your own fitness tracker (e.g., Fitbit, Polar monitor)?  
YES  NO

If so, have you used your fitness tracker within the last 60 days?  
YES  NO
Appendix B

International Physical Activity Questionnaire (IPAQ)

Short Last 7 Days Self-Administered Format

For Use With Young and Middle-Aged Adults (15-69 years)

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the last 7 days. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise, or sport.

Think about all the vigorous activities that you did in the last 7 days. Vigorous physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

1. During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling?

___________ days per week

(  ) No vigorous physical activities → Skip to question 3

2. How much time did you usually spend doing vigorous physical activities on one of those days?

_______ hours per day

_______ minutes per day

(  ) Don’t know/Not sure

Think about all the moderate activities that you did in the last 7 days. Moderate physical activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

3. During the last 7 days, on how many days did you do moderate physical activities like carrying light loads, bicycling at a regular pace, or double tennis?

___________ days per week

(  ) No moderate physical activities → Skip to question 5
4. How much time did you usually spend doing moderate physical activities on one of those days?

        hours per day

        minutes per day

(     ) Don’t know/Not sure

Think about the time you spent walking in the last 7 days. This includes at work and at home, walking to travel from place to place, and any other walking that you have done solely for recreation, sport, exercise, or leisure.

5. During the last 7 days, on how many days did you walk for at least 10 min at a time?

        days per week

(     ) No walking → Skip to question 7

6. How much time did you usually spend walking on one of those days?

        hours per day

        minutes per day

(     ) Don’t know/Not sure

The last question is about the time you spent sitting on weekdays during the last 7 days. Include time spent at work, at home, while doing course work, and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

7. During the last 7 days, how much time did you spend sitting on a week day?

        hours per day

        minutes per day

(     ) Don’t know/Not sure

This is the end of the questionnaire, thank you for participating.
Appendix C

2017 Physical Activity Readiness Questionnaire for Everyone

**General Health Questions**
Please read the 7 questions below carefully and answer each one honestly: circle YES or NO

1. Has your doctor ever said that you have a heart condition or high blood pressure?  
   **YES/NO**

2. Do you feel pain in your chest at rest, during your daily activities of living, or when you do physical activity?  
   **YES/NO**

3. Do you lose balance because of dizziness or have you lost consciousness in the last 12 months? (Please answer NO if your dizziness was associated with over-breathing, including during vigorous exercise)  
   **YES/NO**

4. Have you ever been diagnosed with another chronic medical condition (other than heart disease or high blood pressure)?  
   **YES/NO**  
   a. Please list conditions here:______________________________________________

5. Are you currently taking prescribed medications for a chronic medical condition?  
   **YES/NO**  
   a. Please list medications here:______________________________________________

6. Do you currently have (or have had within the past 12 months) a bone, joint, or soft tissue (muscle, ligament, or tendon) problem that could be made worse by becoming more physically active? (Please answer NO if you had a problem in the past, but it does NOT limit your current ability to be physically active).  
   **YES/NO**  
   a. Please list your conditions here:______________________________________________

7. Has your doctor ever said that you should only do medically supervised physical activity?  
   **YES/NO**

If you answered NO to all of the questions above, you are cleared for physical activity. You do not have to complete the remainder of the questions.

If you answered YES to one or more of the questions above, please complete the following questions.

1. Do you have Arthritis, Osteoporosis, or Back Problems?  
   **YES/NO**  
   a. **If NO, go to Question 2**
   b. Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer NO if you are not currently taking medications or other treatments).  
      **YES/NO**
c. Do you have joint problems causing pain, a recent fracture caused by osteoporosis or cancer, displaced vertebra (e.g., spondylolisthesis), and/or spondylolysis/pars defect (a crack in the bony ring on the back of the spinal column)?  **YES/NO**  
d. Have you had steroid injections or taken steroid tablets regularly for more than 3 months?  **YES/NO**

2. Do you currently have Cancer of any kind?  **YES/NO**  
a. **If NO go to Question 3**  
b. Does your cancer diagnosis include any of the following types: lung/bronchogenic, multiple myeloma (cancer of plasma cells), head, and/or neck?  **YES/NO**  
c. Are you currently receiving cancer therapy (such as chemotherapy or radiotherapy)?  **YES/NO**

3. Do you have a Heart or Cardiovascular Condition? This includes Coronary Artery Disease, Heart Failure, Diagnosed Abnormality of Heart Rhythm  **YES/NO**  
a. **If NO go to Question 4**  
b. Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer NO if you are not currently taking medications or other treatments).  **YES/NO**  
c. Do you have an irregular heart beat that required medical management (e.g., atrial fibrillation, premature ventricular contraction)?  **YES/NO**  
d. Do you have chronic heart failure?  **YES/NO**  
e. Do you have diagnosed coronary artery (cardiovascular) disease and have not participated in regular physical activity in the last 2 months?  **YES/NO**

4. Do you have High Blood Pressure?  **YES/NO**  
a. **If NO go to Question 5**  
b. Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer NO if you are not currently taking medications or other treatments).  **YES/NO**  
c. Do you have a resting blood pressure equal to or greater than 160/90 mmHg with or without medication? (Answer YES if you do not know your resting blood pressure).  **YES/NO**

5. Do you have any Metabolic Condition?  **YES/NO**  
a. **If NO go to Question 6**  
b. Do you often have difficulty controlling your blood sugar levels with foods, medications, or other physician-prescribed therapies?  **YES/NO**  
c. Do you often suffer from signs and symptoms of low blood sugar (hyperglycemia) following exercise and/or during activities of daily living? Signs of hyperglycemia may include shakiness, nervousness, unusual irritability, abnormal sweating, dizziness or light-headedness, mental confusion, difficulty speaking, weakness, or sleepiness.  **YES/NO**
INCREASING PHYSICAL ACTIVITY

d. Do you have any signs or symptoms of diabetes or complications such as vascular disease and/or complications affecting your eyes, kidneys, OR the sensation in your toes and feet?  **YES/NO**
e. Do you have other metabolic conditions (such as current pregnancy-related diabetes, chronic kidney disease, or liver problems)?  **YES/NO**
f. Are you planning to engage in what, for you, is unusually high (or vigorous) intensity exercise in the near future?  **YES/NO**

6. Do you have any Mental Health Problems or Learning Difficulties? This includes Alzheimer’s Dementia, Depression, Anxiety Disorder, Eating Disorder, Psychotic Disorder, Intellectual Disability, Down Syndrome  **YES/NO**
   a. **If NO go to Question 7**
   b. Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer NO if you are not currently taking medications or other treatments).  **YES/NO**
   c. Do you have Down Syndrome AND back problems affecting nerves or muscles?  **YES/NO**

7. Do you have a Respiratory Disease? This includes Chronic Obstructive Pulmonary Disease, Asthma, Pulmonary High Blood Pressure  **YES/NO**
   a. **If NO go to Question 8**
   b. Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer NO if you are not currently taking medications or other treatments).  **YES/NO**
   c. Has your doctor ever said your blood oxygen level is low at rest or during exercise and/or that you require supplemental oxygen therapy?  **YES/NO**
   d. If asthmatic, do you currently have symptoms or chest tightness, wheezing, labored breathing, consistent cough (more than 2 days/week), or have you used your rescue medication more than twice in the last week?  **YES/NO**
   e. Has your doctor ever said you have high blood pressure in the blood vessels of your lungs?  **YES/NO**

8. Do you have a Spinal Cord Injury? This includes Tetraplegia and Paraplegia  **YES/NO**
   a. **If NO go to Question 9**
   b. Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer NO if you are not currently taking medications or other treatments).  **YES/NO**
   c. Do you commonly exhibit low resting blood pressure significant enough to cause dizziness, light-headedness, and/or fainting?  **YES/NO**
   d. Has your physician indicated that your exhibit sudden bouts of high blood pressure (known as Autonomic Dysreflexia)?  **YES/NO**

9. Have you had a Stroke? This includes Transient Ischemic Attack (TTA) or Cerebrovascular Event  **YES/NO**
   a. **If NO go to Question 10**
b. Do you have difficulty controlling your condition with medications or other physician-prescribed therapies? (Answer NO if you are not currently taking medications or other treatments). **YES/NO**

c. Do you have any impairment in walking or mobility? **YES/NO**

d. Have you experienced a stroke or impairment in nerves or muscles in the past 6 months? **YES/NO**

10. Do you have any other medical condition not listed above or do you have two or more medical conditions? **YES/NO**

   a. **If NO, please stop**

   b. Have you experienced a blackout, fainted, or lost consciousness as a result of a head injury within the last 12 months OR have you had a diagnosed concussion within the last 12 months? **YES/NO**

   c. Do you have a medical condition that is not listed (such as epilepsy, neurological conditions, kidney problems)? **YES/NO**

   d. Do you currently live with two or more medical conditions? **YES/NO**

      i. Please list your medical conditions here:
Eating Questionnaire

**Instructions:** The following questions are concerned with the past 4 weeks (28 days) only. Please read each question carefully. Please answer all questions. Thank you.

**Questions 1-12:** Please circle the appropriate number on the right. Remember that the questions only refer to the past 4 weeks (28 days) only.

<table>
<thead>
<tr>
<th>No days</th>
<th>1-5 days</th>
<th>6-12 days</th>
<th>13-15 days</th>
<th>16-22 days</th>
<th>23-27 days</th>
<th>Every day</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Have you been deliberately trying to limit the amount of food you eat to influence your shape or weight (whether or not you have succeeded)?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>2</td>
<td>Have you gone for long periods of time (8 waking hours or more) without eating anything at all in order to influence your shape or weight?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>3</td>
<td>Have you tried to exclude from your diet any foods that you like in order to influence your shape or weight (whether or not you have succeeded)?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>Have you tried to follow definite rules regarding your eating (for example, a calorie limit) in order to influence your shape or weight (whether or not you have succeeded)?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>Have you had a definite desire to have an empty stomach with the aim of influencing your shape or weight?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>6</td>
<td>Have you had a definite desire to have a totally flat stomach?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>7</td>
<td>Has thinking about food, eating, or calories made it very difficult to concentrate on things you are interested in (for example, working, following a conversation, or reading)?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>8</td>
<td>Has thinking about shape or weight made it very difficult to concentrate on things you are interested in (for example, working, following a conversation, or reading)?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>9</td>
<td>Have you had a definite fear of losing control over eating?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
</tr>
</tbody>
</table>
**Questions 13-18**: Please fill in the appropriate number in the boxes on the right. Remember that the questions only refer to the past 4 weeks (28 days).

<table>
<thead>
<tr>
<th></th>
<th>Over the past 4 weeks (28 days)…</th>
<th>No days</th>
<th>1-5 days</th>
<th>6-12 days</th>
<th>13-15 days</th>
<th>16-22 days</th>
<th>23-27 days</th>
<th>Every day</th>
</tr>
</thead>
<tbody>
<tr>
<td>13</td>
<td>How many times have you eaten what other people would regard as an unusually large amount of food (given the circumstances)?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>14</td>
<td>…On how many of these times did you have a sense of having lost control over your eating (at the time you were eating)?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>15</td>
<td>On how many days have such episodes of overeating occurred (i.e., you have eaten an unusually large amount of food and have had a sense of loss of control at the time)?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>16</td>
<td>How many times have you made yourself sick (vomit) as a means of controlling your shape or weight?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>17</td>
<td>How many times have you taken laxatives as a means of controlling your shape or weight?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>18</td>
<td>How many times have you exercised in a driven or compulsive way as a means of controlling your weight, shape, or amount of fat, or to burn off calories?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>
**Questions 19-21:** Please circle the appropriate number. Please note that for these questions the term “binge eating” means eating what others would regard as an unusually large amount of food for the circumstances, accompanied by a sense of having lost control over eating.

<table>
<thead>
<tr>
<th>Over the past 4 weeks (28 days)…</th>
<th>No days</th>
<th>1-5 days</th>
<th>6-12 days</th>
<th>13-15 days</th>
<th>16-22 days</th>
<th>23-27 days</th>
<th>Every day</th>
</tr>
</thead>
<tbody>
<tr>
<td>19 On how many days have you eaten in secret? Do not count episodes of binge eating.</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>20 On what proportion of the times that you have eaten have you felt guilty (felt that you have done something wrong) because of its effect on your shape or weight? Do not count episodes of binge eating</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>21 How concerned have you been about other people seeing you eat? Do not count episodes of binge eating</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>

**Questions 22-28:** Please circle the appropriate number on the right. Remember that the questions only refer to the past 4 weeks (28 days).

<table>
<thead>
<tr>
<th>Over the past 4 weeks (28 days)…</th>
<th>No days</th>
<th>1-5 days</th>
<th>6-12 days</th>
<th>13-15 days</th>
<th>16-22 days</th>
<th>23-27 days</th>
<th>Every day</th>
</tr>
</thead>
<tbody>
<tr>
<td>22 Has your weight influenced how you think about (judge) yourself as a person?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>23 Has your shape influenced how you think about (judge) yourself as a person?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>24 How much would it have upset you if you had been asked to weigh yourself once a week (no more, no less, often) for the next 4 weeks?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>25 How dissatisfied have you been with your weight?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>26 How dissatisfied have you been with your shape?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>27 How uncomfortable have you felt seeing your body (for example, seeing your shape in the mirror, in a shop window reflection, while undressing or taking a bath or shower)?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>28</td>
<td>How uncomfortable have you felt about others seeing your shape or figure (for example, in communal changing rooms, when swimming, when wearing tight clothes)?</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>----</td>
<td>---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
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<td>---</td>
<td>---</td>
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<td>---</td>
</tr>
</tbody>
</table>

What is your weight at present? (Please give your best estimate) __________________________

What is your height? (Please give your best estimate) __________________________

If female: Over the past three-to-four months have you missed any menstrual periods? ______

    If so, how many? __________

    Have you been taking the “pill”? __________
Appendix E

Date: _________
Experimenter: __________
Data Collector (Your Initials): __________
Participant ID: ___________

Baseline

(+)= Experimenter performed the skill correctly
(-)= Experimenter made an error (the skill was performed incorrectly or was not performed when it should have been)
(NA)= Experimenter did not have an opportunity to perform the skill

Data Collection

<table>
<thead>
<tr>
<th>Updates graphs once per day</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feedback on performance is withheld</td>
</tr>
</tbody>
</table>


Contingency Management (CM) Group

(+)= Experimenter performed the skill correctly
(-)= Experimenter made an error (the skill was performed incorrectly or was not performed when it should have been)
(NA)= Experimenter did not have an opportunity to perform the skill

Data Collection

Updates graphs once per day

Calculates goals based on 70th percentile of previous 14 days

Notifies participant (via texting software) of next goal before start of next goal period

If participant meets/exceeds goal, put slip of paper with ID number into lottery (or gives indication in Excel spreadsheet – same one as graphs)

If participant does not meet/exceed goal, put blank slip of paper into lottery (or gives indication in Excel spreadsheet – same one as graphs)

Notifications on entry or non-entry in prize drawing are sent by the morning of the subsequent day

Notifications sent to participants do not include personal info (e.g., name, weight, etc.)

Prize draws occur every 7 days

Notifications on outcome (i.e., winning or losing draw) are sent within 2 hours of the drawing
Appendix G

Date: __________
Experimenter: __________
Data Collector (Your Initials): __________
Participant ID: __________

**Participation-Based Incentive (PBI) Group**

(+): Experimenter performed the skill correctly  
(-): Experimenter made an error (the skill was performed incorrectly or was not performed when it should have been)  
(NA): Experimenter did not have an opportunity to perform the skill

**Data Collection**

<table>
<thead>
<tr>
<th>Updates graphs once per day</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Participant receives a gift card every 7 days</td>
<td></td>
</tr>
<tr>
<td>Amount of gift card given = $5</td>
<td></td>
</tr>
<tr>
<td>Notifications sent to participants do not include personal info (e.g., name, weight, etc.)</td>
<td></td>
</tr>
<tr>
<td>No feedback is provided on performance (i.e., how to earn a gift card)</td>
<td></td>
</tr>
</tbody>
</table>
Appendix H

Date: __________
Experimenter: __________
Data Collector (Your Initials): __________
Participant ID: ___________

**Self-Monitoring (SM) Group**

(+)= Experimenter performed the skill correctly
(-)= Experimenter made an error (the skill was performed incorrectly or was not performed when it should have been)
(NA)= Experimenter did not have an opportunity to perform the skill

**Data Collection**

<table>
<thead>
<tr>
<th>Updates graphs once per day</th>
<th></th>
</tr>
</thead>
</table>

| Feedback on performance is withheld |   |