2019

Effects of a group-deposit prize draw on the step counts of adults

Alex J. McCurdy  
University of the Pacific

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EFFECTS OF A GROUP-DEPOSIT
PRIZE DRAW ON THE STEP COUNTS OF ADULTS

By

Alex J. McCurdy

A Thesis Submitted to the
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In Partial Fulfillment of the
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Behavioral Psychology

University of the Pacific
Stockton, California

2019
EFFECTS OF A GROUP-DEPOSIT PRIZE DRAW ON THE STEP COUNTS OF ADULTS

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EFFECTS OF A GROUP-DEPOSIT
PRIZE DRAW ON THE STEP COUNTS OF ADULTS

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By

Alex J. McCurdy
DEDICATION

This thesis is dedicated to my parents who reinforced curiosity.
ACKNOWLEDGEMENTS

I stumbled upon this field due to a chance meeting with Daphne Hartzheim. To her I owe opening the door to the most powerful ideas I have yet encountered. I also am also deeply grateful to Carla Burji for her ceaseless patience, support, and confidence in me. I am very grateful for the influence Dr. Normand has had on me. His knowledge, clarity, and long-term dreams of what ABA can achieve have inspired me to dream along with him. I thank Dr. Jensen for his helpful feedback and comments along the way. I also thank Dr. Raiff for exemplifying a passion for improving health with behavior analysis.
Effects of a Group-Deposit Prize Draw on the Step Counts of Adults

Abstract

By Alex J. McCurdy
University of the Pacific
2019

The World Health Organization (WHO, 2016) reports that 3.2 million deaths per year are attributable to physical inactivity, making it the fourth leading risk factor for global mortality. Physical inactivity is also a key risk factor for noncommunicable diseases such as cardiovascular disease, cancer, and diabetes (WHO, 2018). Globally, 1 in 4 adults is not active enough and, therefore, foregoes a myriad of health benefits associated with Physical Activity (PA; WHO, 2018). In the United States, only about 1 in 5 (21%) adults meet the 2008 Physical Activity Guidelines set by the Centers for Disease Control and Prevention (CDC, 2018). The CDC currently recommends adults engage in 150 min of moderate-intensity aerobic activity per week (CDC, 2018). Translated to steps, the recommendation can be met by taking 3,000 steps in 30 min, 5 days per week (Marshall et al., 2009). Physical inactivity is also a major contributor to obesity (WHO, 2018). According to the WHO (2018), worldwide prevalence of obesity almost tripled since 1975. In the United States, the medical costs of obesity were estimated to be $147 billion, or 10% of all medical spending (Finkelstein, Trogdon, Cohen, & Dietz, 2009). To combat the many problems associated with physical inactivity, the CDC (2015), the WHO (2018), and the American Heart Association (2018) prescribe increased PA. Furthermore, increased PA contributes to a variety of other health benefits, including a decreased risk for
cardiovascular disease, type 2 diabetes, some cancers, as well as improved mental health, and increased life expectancy (CDC, 2018).
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Chapter 1: Introduction and Literature Review

It is clear that developing interventions to increase PA is of utmost importance. One promising intervention strategy is Contingency Management (CM), in which a target behavior is measured, tangible reinforcers are delivered if the target behavior occurs, and the reinforcer is withheld if the target behavior does not occur (Petry, 2000). CM is based on the operant conditioning principle of reinforcement, whereby a consequence follows a behavior and increases the future likelihood of that behavior (Silverman, Jarvis, Jessel, Lopez, 2016). CM was developed to address overeating (Stuart, 1967), but researchers have since used CM to address a host of health challenges (e.g., drug use, treatment adherence, therapy attendance). One of the earliest forms of CM used vouchers instead of money as reinforcement, because vouchers decrease the likelihood that participants can purchase items related to problem behavior, (e.g., buying cocaine during a cocaine abstinence intervention; Higgins, 1991). CM has been shown to be an effective intervention for a variety of problems including alcohol abuse (e.g., Miller, 1975; Petry, Martin, Cooney, & Kranzler, 2000), smoking cessation (Alessi, Petry, & Urso, 2008; Cahill, Hartmann-Boyce, Perera, 2015; Dallery, Raiff, & Grabinski, 2013; Dunn et al., 2008), therapy attendance (Carey & Carey, 1990; Chaisson et al., 1996; Stevens-Simon et al., 1997), work attendance (e.g., Silverman et al., 1996b), PA (Kurti & Dallery, 2013; Patel et al., 2016; Washington, Banna, & Gibson, 2014; Washington, McMullen, Devoto, 2016), and obesity and weight loss (see Jeffery, 2012, for a review). The accumulation of evidence that CM interventions are effective resulted in CM being identified by the United Kingdom’s National Institute for Health and Clinical Excellence as one of the most effective psychosocial interventions for drug abuse (Pilling, Strang, & Gerada, 2007), specifically opioid abstinence (Bickel et al., 1997; Stitzer et al., 1980) and cocaine abstinence (Higgins et al., 1993; Silverman
et al., 1996a). Although studies have shown the potential of CM to change behavior, researchers report that clinical adoption continues to be minimal due, at least in part, to the cost of CM interventions (Dallery, Meredith, & Glenn, 2008; Petry, 2000; Silverman, Roll, & Higgins, 2008).

CM interventions are effective, but they come at a cost. Clinicians have identified these costs as a primary barrier to clinical adoption (Kirby, Benishek, Dugosh, & Kerwin, 2006). The initial CM intervention using vouchers cost an average of $600 per participant over 24 weeks (Higgins et al., 1993), and some voucher interventions cost as much as $3480 per participant over 27 weeks (e.g., Silverman, Chutuape, Bigelow, & Stizter, 1999). Petry (2000) also noted the overlooked costs of personnel required to run these programs (e.g., urine testing, running prize draws, picking up prizes to be raffled). One cost-effective rendition of CM is the therapeutic workplace where drug abstinence is reinforced with employment; however, this model still has historically been supported by large grants from the National Institute on Drug Abuse (Silverman et al., 2007). Lastly, some researchers have suggested that community clinics will find it difficult to adopt interventions for which the costs are not reimbursed by insurance providers or federal programs (Roll, Madden, Rawson, & Petry, 2009).

Decreasing costs of CM interventions while maintaining effectiveness and acceptability has been a focus of CM researchers for many years (see Jeffery, 2012, and Petry, 2000, for a review). On the one hand, higher payouts improve the effectiveness, but increase the financial costs, of CM interventions (Silverman, Chutuape, Bigelow, & Stitzer, 1999; Sindelar, Elbel, & Petry, 2007). On the other hand, decreased payouts of CM interventions reduces efficacy (Petry et al., 2004). Recent attempts have been made to develop interventions that decrease costs
without compromising effectiveness. Two CM interventions have been identified for their cost-saving potential: prize-based CM and deposit contracts.

Prize-based CM emerged out of a concern about the costs of voucher-based interventions, and researchers have demonstrated the feasibility to decrease associated CM costs without compromising effectiveness (Petry, Alessi, Marx, Austin, & Tardif, 2005). These procedures involve participants drawing tickets from a prize bowl contingent on goal achievement. Tickets are distributed so that half of the tickets have monetary value and half are praise only (e.g., “Great job on your goal!”). Winning tickets range from small (e.g., $1 coupon to McDonalds) to large (e.g., iPod). Tickets are distributed so that there is a higher chance of winning a small prize and a lower chance to win a large prize. Prize-based procedures have been shown effective in treating cocaine addiction (Petry, et al., 2004), alcohol abstinence (Petry, et al., 2000), smoking cessation (Alessi, Petry, & Urso, 2008; Ledgerwood, Arfken, Petry, & Alessi, 2014), promoting weight loss (Petry, Barry, Pescatello, & White, 2011), and increasing PA (Washington, Banna, & Gibson, 2014). Two practical benefits result from the use of prize-based procedures: First, behavior that meets the response criteria will be reinforced variably, potentially resulting in reduced payouts during intervention. Second, participants have the chance to draw high-magnitude reinforcers (large tickets) which improves effectiveness (Silverman, Chutuape, Bigelow, & Stitzer, 1999; Sindelar, Elbel, & Petry, 2007).

Washington et al. (2014) used a prize-based intervention to increase step counts, with a cost of $12.60 per participant ($126 for 10 participants) for the duration of the 3-week study. Participants earned the opportunity to draw a prize if they met a specified step criterion. Step criteria were determined based on a percentile schedule of reinforcement whereby step counts from the previous 7 days were rank-ordered, with the participant needing to exceed the steps
from the 5\textsuperscript{th} highest day. Results showed that the prize-based intervention was a cost-effective way to increase PA. Even though researchers have gradually decreased implementation costs, the authors noted that this is not a sustainable long-term intervention as researchers will not have the money to fund prize-based interventions continually. The authors suggested that future research should assess the effectiveness of deposit contracts alongside prize-based interventions, as the literature on deposit contracts suggests increased savings and effects might be achieved by combining the two interventions.

The deposit contract is another low-cost form of CM. Deposit contracting is a procedure in which participants deposit money at the beginning of a study that can be earned back during the CM intervention based on goal attainment, with participants thereby funding their own payouts (Silverman, Roll, & Higgins, 2008). Washington, McMullen, & Devoto (2016) directly compared a standard CM intervention to deposit contracts and showed that deposit contracts increased PA as well as the standard CM intervention did. Nineteen participants who took fewer than 10,000 steps during a 1-week baseline were randomly assigned to a deposit or a no-deposit group. Participants in the deposit group were required to deposit $25. All participants earned $1.50 for each day that a step goal was met across 21 days of intervention, with step goals determined using a percentile schedule of reinforcement (Galbicka, 1994). The deposit contract increased step counts as much as standard CM; however, the authors were concerned that the deposit might negatively affect acceptability to college students so they matched the deposits of the of deposit group. (The cost to researchers for the deposit group was $0.48 per participant.) This resulted in participants potentially earning more than they deposited. The matched deposit limits the conclusions that can be drawn about the effectiveness of the deposit group because the researchers subsidized payouts.
These two CM interventions have shown promise in addressing physical inactivity at a relatively low cost, thereby addressing a myriad of health challenges. First, prize-based reinforcement has been shown to increase PA and minimize costs by using intermittent, rather than continuous, reinforcement. Second, deposit contracts have increased PA and minimized costs by using participants’ money to fund interventions. However, limited clinical adoption continues to be a challenge. Therefore, developing financially sustainable interventions might promote wider clinical adoption (i.e., entrepreneurs or health professionals applying CM interventions to increase PA). The purpose of the current study was to examine the effects of a prize-based intervention funded by pooling participants’ deposits on individuals’ steps counts.
Chapter 2: Methodology

Subjects and Setting

We recruited 6 adults from the local community using flyers, Facebook advertisements, and word of mouth. Prior to the start of the study, the principal investigator met with participants, explained the purpose of the study, obtained signed consent forms, distributed pedometers. Participants completed the Physical Activity Readiness Questionnaire for Everyone (PAR-Q+, see Appendix B), the Readiness to Change Questionnaire (see Appendix C), and a demographics questionnaire (see Appendix D). The PAR-Q+ is a screening tool that is used to identify at-risk participants for whom increased PA might be harmful (Warburton, Jamnik, Bredin, & Gledhill, 2011). For example, one question asks, “Has your doctor ever said that you have a heart condition OR high blood pressure?” If a participant checked the “Yes” box, they would have been excluded from the study. However, no participants were excluded because no participants checked the “Yes” box. The Readiness to Change Questionnaire is an additional screening tool that was used to assess participants’ “desire” to increase their PA. We used a modified version of the University of Rhode Island Change Assessment Scale (DiClemente & Hughes, 1990) that focused on PA. Participants were asked to rate how much they agreed or disagreed with statements about their current engagement in PA from 1 (Strongly Disagree) and 5 (Strongly Agree). For example, one statement read, “As far as I am concerned, my physical activity level is not a problem that needs changing.” The primary difference between the PAR-Q+ and the Readiness to Change Questionnaire is that the PAR-Q+ assesses health readiness and the Readiness to Change Questionnaire attempts to predict the likelihood that behavior will actually change. The demographics questionnaire gathered information about height, weight, income, age, gender, and ethnicity. We conducted all meetings with the participants in the
Psychology Department at the University of the Pacific. All participant information was stored in a locked filing cabinet in an office in the same department. Data sheets were de-identified to protect each participant’s privacy.

Materials

Participants were asked to wear Fitbit Zip® pedometers, which have been validated in previous studies and deemed suitable for use in research (Tully, McBride, Heron, & Hunter, 2014). Participants height were measured using a Seca 220 Height Measuring Unit (Seca 220) and weight was measured with a Seca 700 (Seca 700). Participants were required to have access to a device (e.g., smartphone or computer) so that the Fitbit Zip automatically synced steps counts via the Fitbit App and where video of the prize draws were sent and viewed.

Procedure

An ABA reversal design was used in which participants experienced baseline for 12 days followed by intervention for 21 days. Participants returned to baseline for another 7 days after the intervention phase. The 12-day baseline provided sufficient daily step-count data so that intervention goals were set at approximately the 70th percentile of a percentile schedule of reinforcement. The 3-week intervention length is consistent with previous research (Dallery et al., 2008; Washington et al., 2014; Washington et al., 2016), and allowed participants to experience the percentile schedule of reinforcement for long enough to potentially increase their steps to meaningful levels.

Response definition and measurement. Daily step counts were the primary dependent variable. Daily step count was defined as all steps taken during a 24-hr period (12am-12am) while wearing the Fitbit pedometer on the hip. Body Mass Index (BMI) was a secondary dependent variable. Participant BMI data were calculated from height and weight.
measurements, which took place in a laboratory in the Psychology Department. The laboratory contained a two-way mirror, measuring equipment, chairs, weighing scale, height measurer, and desks. Measurements were completed during intake and at the end of the study. Daily step counts were downloaded from the Fitbit website into an Excel spreadsheet.

**Baseline.** Experimenters asked the participants to wear their pedometers for 7 days before intervention. However, due to the variability evident in the data during the initial 7 days, the baseline was extended to 12 days. Reminders were sent between 8 p.m. and 9 p.m. prior to the following morning’s prize draw via SMS message to participants to sync their Fitbit if the step data were not being updated automatically.

**Step goals.** Step criteria were determined using a percentile schedule of reinforcement (Galbicka, 1994). Step counts from the previous 7 days were rank-ordered, with the participant needing to exceed the steps from the 3rd highest day of the previous 7 days. For example, if steps from the previous 7 days were ordered by rank from most to least and were 7,000, 6,000, 5,000, 4,000, 3,000, 2000, and 1,000, the participant would need to exceed 5,000 steps to meet their goal. Galbicka (1994) recommended that the criterion should be set at the 70th percentile, meaning a participant would need to take more steps than they did on 5 of the previous 7 days. Each goal was based on the most recent 7 days of data. To prevent the possibility of reinforcing decreasing PA, goals were never set lower than the most recent achieved goal. Daily goals were sent via text message to the participant. All participants were asked to verify the upcoming goal by reiterating their goal for the next day by sending an SMS message containing the day’s step goal back to the primary investigator after the participant had received their daily goal. This helped ensure the participant knew their goal for the next day. Daily goals read: “Good morning (participant name). Your goal for today is 6,457 steps. Please text me back the goal to confirm.”
Prize draws. Prize draws began after the initial baseline. We requested deposits before the initial baseline to reduce the number of campus visits participants were required to make. The $42 deposit was based on Patel et al. (2016), a study in which participants were given $42 at the onset of the study and lost $1.40 per day if they didn’t meet their daily step goal (Patel et al., 2016), as well as prize-based research that used payouts of approximately $2 per day (Petry et al., 2011; Washington et al., 2014). At $2 per day and 21 days of intervention, the total deposit equals $42. Each participant’s $42 deposit was combined with all other participant deposits and used as part of the potential payouts for all participants. A total of 126 tickets were put into a prize bowl (21 potential days to earn prize draws for 6 participants) and distributed in the following manner: 63 tickets (50% of tickets) were praise only (e.g., “Great job!” or “Keep up the good work!”), 53 tickets (42% of tickets) were small prizes (i.e., $2), 7 tickets (6% of tickets) were medium prizes (i.e., $10), 1 ticket was a large prize (i.e., $75).

Prize draws were earned contingent on goal achievement and occurred daily. If a participant met their daily step goal, the researcher sent the participant a video of the researcher reciting the step goal and the actual number of steps taken the previous day. The video showed the researcher selecting a ticket from the prize bowl and then holding the drawn ticket in view of the camera. Afterwards, experimenter sent a text message with the new goal and total earnings. Earning totals were documented by the experimenter electronically via an Excel spreadsheet. Participants were given the option to collect their cash rewards at their discretion. All deposited money was kept in a locked closet in a locked safe within the main administrative office in the Psychology Department.

Social validity survey and debrief. Following the second baseline, participants were debriefed and then completed a social validity survey (see Appendix E). The debrief provided a
summary of the study and explained the purpose of the study. The social validity survey
gathered responses from participants about the acceptability of the intervention, whether they
would participate again in such a program, how likely they were to recommend this intervention
to others, and provided the opportunity to continue the intervention for an additional 2 weeks.
One participant elected to continue and was asked to deposit $42. The ticket values and
distribution were calculated to be as similar as possible to intervention (e.g., 50% to earn praise
tickets, ticket magnitude, ticket distribution).
Chapter 3: Results

Participant ages ranged from 23 to 61 years old. There were five female participants and one male participant. Two participants reported Asian ethnicity, three participants reported Hispanic ethnicity, and one participant reported Caucasian ethnicity. See Table 1 for a summary of the demographic information. Based on BMI, two participants were in the healthy category, while four participants were in the obese category (Table 4). All participants met inclusion criteria based on the PAR-Q+. One participant fell into the “Precontemplation” category, all other participants were in the “Contemplation” category (see Appendix F).

Table 1: Participant demographics including age, sex, ethnicity, and income.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Age</th>
<th>Sex</th>
<th>Ethnicity</th>
<th>Income</th>
</tr>
</thead>
<tbody>
<tr>
<td>P313</td>
<td>61</td>
<td>F</td>
<td>White</td>
<td>$51k - $75k</td>
</tr>
<tr>
<td>P314</td>
<td>34</td>
<td>M</td>
<td>Hispanic</td>
<td>$26k - $50k</td>
</tr>
<tr>
<td>P315</td>
<td>38</td>
<td>F</td>
<td>Hispanic</td>
<td>$76k - $100k</td>
</tr>
<tr>
<td>P316</td>
<td>23</td>
<td>F</td>
<td>Asian</td>
<td>$0 - $26k</td>
</tr>
<tr>
<td>P317</td>
<td>42</td>
<td>F</td>
<td>Hispanic</td>
<td>$26k - $50k</td>
</tr>
<tr>
<td>P318</td>
<td>23</td>
<td>F</td>
<td>Asian</td>
<td>$0 - $26k</td>
</tr>
</tbody>
</table>

All participants mean daily step-count increased from 6,584 during baseline to 8,186 during intervention (+20%). In total, participants met 60% of the goals set (72 of 120 goals with 6 days excluded due to an injury suffered by one participant; see Table 2). Of the total goals met, four of six participants were primarily responsible, meeting 86% of the total met goals. Excluding the two low performing participants, 79% of all goals were met (mean daily step-count in baseline: 6,071, mean daily step-count in intervention: 8,542, +30%). Additionally, a sustained upward trend throughout intervention was evident for four of six participants.
In total, participants earned $128 of the $252 deposited (see Table 2). Participants drew 32 praise tickets, thirty-four $2 tickets, and six $10 tickets. The $75 ticket went undrawn. Participants had the option to obtain their earnings at any time, but all participants elected to collect their earnings at the end of the study.

Table 2: Participant earnings and met goals. P318 only included 15 goals due to her sprained ankle.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Goals Met</th>
<th>Total Earned</th>
<th>Number of Praise Draws</th>
<th>% Praise Draws</th>
<th>Number of Money Draws</th>
<th>% Money Draws</th>
</tr>
</thead>
<tbody>
<tr>
<td>313</td>
<td>5 (24%)</td>
<td>$6.00</td>
<td>2</td>
<td>40%</td>
<td>3</td>
<td>60%</td>
</tr>
<tr>
<td>314</td>
<td>5 (24%)</td>
<td>$8.00</td>
<td>1</td>
<td>20%</td>
<td>4</td>
<td>80%</td>
</tr>
<tr>
<td>315</td>
<td>12 (57%)</td>
<td>$20.00</td>
<td>6</td>
<td>50%</td>
<td>6</td>
<td>50%</td>
</tr>
<tr>
<td>316</td>
<td>16 (76%)</td>
<td>$36.00</td>
<td>6</td>
<td>38%</td>
<td>10</td>
<td>63%</td>
</tr>
<tr>
<td>317</td>
<td>19 (90%)</td>
<td>$38.00</td>
<td>8</td>
<td>42%</td>
<td>11</td>
<td>58%</td>
</tr>
<tr>
<td>318</td>
<td>15 (100%)</td>
<td>$20.00</td>
<td>9</td>
<td>60%</td>
<td>6</td>
<td>40%</td>
</tr>
<tr>
<td>Totals</td>
<td>72 (60%)</td>
<td>$128.00</td>
<td>32</td>
<td>44%</td>
<td>40</td>
<td>56%</td>
</tr>
</tbody>
</table>

While favorability ratings were high for all participants, only one participant elected to participate for an additional 2 weeks when given the opportunity to do so (Table 3). All participants reported either a “4” or “5” on “Question 9” indicating high favorability ratings. Participants viewed the $42 deposit as a reasonable amount and the experience to be worth the money. In general, participants reported the goals to be useful and not too burdensome (see Appendix G).
Table 3: Social Validity Survey. Participant responses on a Likert scale from 1-5, 1 being strongly disagree, and 5 being strongly agree. And one-open ended question soliciting information about changes to the study the participant would recommend.

<table>
<thead>
<tr>
<th>Question</th>
<th>P313</th>
<th>P314</th>
<th>P315</th>
<th>P316</th>
<th>P317</th>
<th>P318</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Would you like to continue in the study for an additional 2 weeks?</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>2. The deposit amount ($42) was too high.</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>3. The experience was worth the money.</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>4. The daily reminders via text about daily step goals were helpful.</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>5. The pedometer was not a useful tool for tracking steps.</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>6. The daily step goals were helpful in increasing my physical activity.</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>7. The increasing step goals were too burdensome.</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>8. I am happy with the overall experience.</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>9. Was there any portion of the experience you would like to change? If so, what change(s) do you recommend?</td>
<td>None</td>
<td>&quot;More diverse prizes to make it more fun.&quot;</td>
<td>&quot;Praise was not reinforcing.&quot;</td>
<td>None</td>
<td>None</td>
<td>&quot;More chances to win.&quot;</td>
</tr>
</tbody>
</table>
During the initial baseline, P313 had a mean daily step-count of 8,375 (range: 3,952 to 11,541). Her step counts were high and stable. During intervention, P313’s mean daily step-count was 8,294 (-81 mean change from initial baseline, range: 4,146 to 13,388). P313 met 5 of 21 goals (24%) resulting in five prize draws. Of the five prize draws, she drew winning tickets three times (two tickets were praise only). All winning tickets were $2 in value, totaling $6.

During the return to baseline, the participant’s mean daily step-count was 8,748 (+454 mean change from intervention, range: 4,117 to 11,581). Data are displayed in Figure 1.

![Figure 1: P313’s step counts in initial baseline, intervention, and the return to baseline. Dashed lines indicate the percentile schedule goals sent to participants.](image)

At initial weigh-in P313’s BMI was 22.6. After the return to baseline, P313’s BMI was 23.4 (+0.8 change from the initial weigh-in; see Table 4). P313 wore the Fitbit every day of the intervention; however, she mentioned that there were days it was difficult to wear as instructed (e.g., if she wore a dress to work). P313 did not elect to continue with the study for an additional 2 weeks. Overall, her ratings of the intervention on the social validity survey were favorable (see
Table 3). However, she stated to the experimenter that, “The deposit amount was too low to be motivating.” When asked what deposit amount might be more motivating, P313 stated, “$200” (see Appendix G). P313 apologized for not meeting more goals and attributed the lack of goal achievement to her challenges with mental health (unrelated to the study).

**P314**

In initial baseline, P314’s daily step counts were somewhat variable with 3 of 12 days unrecorded due to participant not wearing the Fitbit. P314’s mean daily step-count in initial baseline was 6,485 (range: 1,523 to 11,884). During intervention, P314’s mean daily step-count was 6,653 (+168 mean change from initial baseline, range: 1,523 to 12,144). Of 21 days of intervention, the participant failed to wear his Fitbit a total of 4 days. P314 met 5 of 21 goals (24%) resulting in five prize draws. P314 earned $8 with four $2 draws, and one draw resulting in a praise-only ticket. In the return to baseline, the participant’s mean daily step-count was 5,471 (-1,182 mean change from intervention, range: 1,918 to 9,006). P314 did not wear the Fitbit 1 day during the return to baseline. Data are displayed in Figure 2.
Figure 2: P314’s step counts in initial baseline, intervention, and the return to baseline. Dashed lines indicate the percentile schedule goals sent to participants.

At initial weigh-in P314’s BMI was 22.9. After the conclusion of return to baseline, P314’s BMI was 22.0 (-0.9. change from the initial weigh-in; see Table 4). In total, P314 had 8 days of no data. He consistently reported that, “I forgot to put it on.” P314 did not elect to continue for 2 additional weeks. Overall, his ratings of the study on the were favorable (see Table 3). P314 stated that him not wearing the Fitbit was a good indication of how motivated he was to meet the goals. About the goals, specifically, he stated, “When I’m tired after work, thinking about the $2 wasn’t motivating enough compared to life and rewards from relaxing.” Moreover, P314 stated that his more preferred deposit amount would have been upwards of $100.

P315

During initial baseline, P315’s mean daily step-count was 3,073 (range: 145 to 5,978). During intervention, P315’s mean daily step-count was 4,837 (+1,764 mean change from initial baseline, range: 770 to 7,579). P315 met 12 of 21 goals (57%) resulting in 12 prize draws. Prize-draw earnings totaled $20: 5 prize draws were $2 tickets, 1 prize draw was a $10 ticket, and 6 draws were praise only. In the return to baseline, P315’s mean daily step-count was 4,387 (-450 mean change from intervention, range: 2,057 to 7,023). Data are displayed in Figure 3.
At initial weigh-in P315’s BMI was 49.4. After the return to baseline, P315’s BMI was 49.6 (+0.2 change from the initial weigh-in; see Table 4). P315’s ratings of the intervention on the social validity survey were very favorable (see Table 2). When asked how motivating the lottery was, she responded, “It was motivating after I drew a $10 ticket.” Referring to the lottery, she stated, “I didn’t like it, because when I met my goal, I wouldn’t get the reinforcement…” P315 indicated that the upper limit of what she would deposit was $100.

P315 was the only participant who chose to continue for 2 additional weeks. During that time, P315’s mean daily step-count was 6,048 (+1,661 mean change from the return to baseline, range: 2,169 to 10,469). She met 8 of 14 goals (57%) resulting in two $2 tickets, one $10 ticket, and five praise tickets. Data are depicted in Figure 3.

**P316**

During initial baseline, P316’s mean daily step-count was 5,257 (range: 1,149 to 8,607). P316’s mean daily step-count during intervention was 8,769 (+3,512 mean change from initial
baseline, range: 6,113 to 12,821). P316 met 16 of 21 goals (76%) resulting in 16 prize draws. Prize-draw earnings totaled $36: 8 prize draws were $2 tickets, two prize draws were $10 tickets, and six draws were praise only. During the return to baseline, P316’s mean daily step-count was 4,159 (-4,610 mean change from intervention, range: 3,603 to 4,805) with 2 days missing because she left the Fitbit at home before she went out of town on vacation. Data are displayed in Figure 4.

Figure 4: P316’s step counts in initial baseline, intervention, and the return to baseline. Dashed lines indicate the percentile schedule goals sent to participants.

At initial weigh-in P316’s BMI was 31.2. After the return to baseline, P316’s BMI was 30.6 (-0.6 change from the initial weigh-in; see Table 4). Results from the Social Validity Survey indicate the intervention was highly favored, however, she did not sign up for 2 additional weeks. When asked if she liked the lottery, P316 stated, “I felt like the increments were fair, even though small, it seemed fair.” When asked if she liked the video, she stated, “Yea, because I could see it wasn’t rigged.”
P317’s mean daily step-count during initial baseline was 9,635 (range: 4,033 to 13,542). P317’s mean daily step-count during intervention was 12,463 (+2,828 change from initial baseline, range: 4,950 to 19,144). P317 met 19 of 21 goals (90%) resulting in 19 prize draws. Prize-draw earnings totaled $38: nine prize draws were $2 tickets, two prize draws were $10 tickets, and eight draws were praise only. During the return to baseline, P317’s mean daily step-count was 11,217 (-1,246 mean change from the return to baseline, range: 7,726 to 19,403). Data are displayed in Figure 5.

![Figure 5](image.png)

At initial weigh-in P317’s BMI was 34.5. After the return to baseline, P317’s BMI was 35.5 (+1.0 change from the initial weigh-in; see Table 4). Results from the Social Validity Survey indicate the intervention was favored, however, she did not sign up for 2 additional weeks. When asked if she liked the goals, P317 stated, “Yes, I liked the challenge. However,
some days were very difficult to be motivated because I was sad that my daughter left for college.”

**P318**

During initial baseline, P318’s mean daily step-count was 6,318 (range: 3,857 to 13,169). On Day 28 of intervention P318 sprained her ankle on a camping trip. No goals were sent to the participant, but the participant elected to keep wearing the Fitbit until the end of study. P318’s mean daily step-count during intervention, excluding days after the ankle sprain, was 9,720 (+3,402 change from initial baseline, range: 5,643 to 14,805). P318 met 15 of 15 goals (100%) before the sprain, resulting in 15 prize draws. Prize-draw earnings totaled $20: five prize draws were $2 tickets, one prize draw was a $10 ticket, and nine draws were praise only. Data are displayed in Figure 6.

![Figure 6: P318’s step counts in initial baseline, intervention, and the return to baseline. Dashed lines indicate the percentile schedule goals sent to participants.](image-url)
At initial weigh-in P318’s BMI was 34.4. After the return to baseline, P318’s BMI was 35.1 (+0.7 change from the initial weigh-in; see Table 4). Results from the Social Validity Survey indicate the intervention was highly favored. However, she decided to not sign up for 2 additional weeks citing her sprained ankle. When discussing the intervention, P318 stated, “I would have liked another measure besides just step counts because I felt like going on a walk around the block was a very different workout than going to the gym and running on the treadmill, but the pedometer wouldn’t recognize the difference.” She also noted, “$42 was just the right amount. Anything more than $50, I probably wouldn’t have signed up.”

Table 4: Participant height, weight, and changes in BMI at the onset and conclusion of the study.

<table>
<thead>
<tr>
<th>Participant</th>
<th>Height</th>
<th>Initial Weight</th>
<th>Final Weight</th>
<th>Initial BMI</th>
<th>Weight Status</th>
<th>Final BMI</th>
<th>Weight Status</th>
<th>BMI Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>313</td>
<td>5'5.5''</td>
<td>138</td>
<td>143</td>
<td>22.6</td>
<td>Healthy</td>
<td>23.4</td>
<td>Healthy</td>
<td>0.8</td>
</tr>
<tr>
<td>314</td>
<td>5' 10''</td>
<td>159.5</td>
<td>153</td>
<td>22.9</td>
<td>Healthy</td>
<td>22</td>
<td>Healthy</td>
<td>-0.9</td>
</tr>
<tr>
<td>315</td>
<td>5' 6''</td>
<td>306</td>
<td>307</td>
<td>49.4</td>
<td>Obese</td>
<td>49.6</td>
<td>Obese</td>
<td>0.2</td>
</tr>
<tr>
<td>316</td>
<td>5' 1''</td>
<td>165</td>
<td>162</td>
<td>31.2</td>
<td>Obese</td>
<td>30.6</td>
<td>Obese</td>
<td>-0.6</td>
</tr>
<tr>
<td>317</td>
<td>5' 4''</td>
<td>201</td>
<td>207</td>
<td>34.5</td>
<td>Obese</td>
<td>35.5</td>
<td>Obese</td>
<td>1</td>
</tr>
<tr>
<td>318</td>
<td>5' 1''</td>
<td>182</td>
<td>186</td>
<td>34.4</td>
<td>Obese</td>
<td>35.1</td>
<td>Obese</td>
<td>0.7</td>
</tr>
</tbody>
</table>

**Markov Chains Analysis**

A Markov chains analysis (see Gottman & Roy, 1990, for a review) was conducted to analyze the probabilities of events (see Figure 7). The Markov chains analysis is a type of sequential analysis that provides a summary of the probabilities of certain events given the occurrence of other temporally-related events. Four primary events were analyzed: drawing a winning ticket, drawing a praise ticket, meeting a goal, and failing to meet a goal. The four primary events’ probabilities were calculated for each previous event (i.e., after drawing a
winning ticket, after drawing a praise ticket, after meeting a goal, and after failing to meet a goal). For example, if a participant met a step goal, the probability of meeting the next day’s step goal compared to the probability of failing to do so can be determined. Calculations were made by taking the sum of each type of event across all participants and determining the likelihood that event either predicted goal achievement, goal failure, drawing a winning, or drawing a praise ticket. The principal investigator entered all daily step goals into an Excel spreadsheet. For all four events, he determined whether the next day’s step goal was met or not. If the next day’s step goal was met, then a “1” was inserted into the spreadsheet. Likewise, if the next day’s step goal was not met a “1” was recorded into the unmet column. Totals were summed at the bottom of the spreadsheet. Probabilities were then calculated by dividing the total frequency of events by the total possible for each of the four events. For example, P313 met a total of five goals and met only one goal following successful goal achievement. Therefore, the probability that she met the next goal was .20 (see Table 5). Some findings of the analysis were notable: First, there was no difference in the probability of meeting a goal if a participant earned money versus not earning money (both were .76). Second, if a participant met a goal, the probability of them meeting the next goal was .78 versus if a participant did not meet a goal, the probability that they met the next day’s goal was .57.
Figure 7: Sequential analysis of the probabilities of events. Numerals are the probabilities of an event based on the previous event.

Table 5: Sequential analysis of goal achievement and prize draws by participant.

<table>
<thead>
<tr>
<th>Subject</th>
<th>Met goal</th>
<th>Met next goal</th>
<th>Did not meet goal</th>
<th>Met next goal</th>
<th>Did not meet goal</th>
<th>Drew Money</th>
<th>Met next goal</th>
<th>Did not meet goal</th>
<th>Drew Praise</th>
<th>Met next goal</th>
<th>Did not meet goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>P313</td>
<td>0.24</td>
<td>0.20</td>
<td>0.80</td>
<td>0.76</td>
<td>0.27</td>
<td>0.73</td>
<td>0.60</td>
<td>0.20</td>
<td>0.80</td>
<td>0.40</td>
<td>0.0</td>
</tr>
<tr>
<td>P315</td>
<td>0.57</td>
<td>0.50</td>
<td>0.50</td>
<td>0.43</td>
<td>0.63</td>
<td>0.38</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
<td>0.50</td>
</tr>
<tr>
<td>P316</td>
<td>0.76</td>
<td>0.87</td>
<td>0.13</td>
<td>0.24</td>
<td>0.40</td>
<td>0.60</td>
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<td>0.90</td>
<td>0.10</td>
<td>0.37</td>
<td>0.80</td>
</tr>
<tr>
<td>P317</td>
<td>0.91</td>
<td>0.89</td>
<td>0.11</td>
<td>0.09</td>
<td>1.0</td>
<td>0.0</td>
<td>0.58</td>
<td>0.90</td>
<td>0.10</td>
<td>0.42</td>
<td>0.88</td>
</tr>
<tr>
<td>P318</td>
<td>1.0</td>
<td>1.00</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
<td>0.40</td>
<td>1.0</td>
<td>0.0</td>
<td>0.60</td>
<td>1.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Total</td>
<td>0.68</td>
<td>0.78</td>
<td>0.22</td>
<td>0.43</td>
<td>0.57</td>
<td>0.54</td>
<td>0.76</td>
<td>0.24</td>
<td>0.46</td>
<td>0.76</td>
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</tr>
</tbody>
</table>
Chapter 4: Discussion

Physical inactivity is correlated with many non-communicable diseases and is a serious health concern (WHO, 2018). Governments, scientists, leading medical institutions, and public health institutions all stress the importance of developing effective interventions to increase PA (AHA, 2018; CDC, 2018; USDHHS, 2018; WHO, 2018). CM is a powerful intervention strategy that has been shown to increase PA (Kurti & Dallery, 2013; Petry, Andrade, Barry, & Byrne, 2013; Washington et al., 2014; Washington et al., 2016), although the financial costs of CM interventions likely have inhibited widespread dissemination (Kirby, Benishek, Dugosh, & Kerwin, 2006). Inexpensive and effective interventions to increase PA are needed.

In the current study, two types of CM interventions (deposit contracts and prize-based CM) were combined to create a financially sustainable intervention. The goal of the study was to evaluate the effects of group-deposit prize draw on the step counts of adults. Participants were mostly female with one male participant. Ages ranged from 23-61, and incomes ranged widely from $0-$26k to $76k-$100k. The intervention moderately increased the daily step counts for four of six participants in an inexpensive manner: Participants earned an average of only $21 during the intervention. Moreover, three out of those four participants’ physical activity closely followed the percentile schedule goals (P316, P317, P318). A total of 72 of 120 (60%) goals were met. Participants drew $128 of $252 (51%) in the prize bowl. Although all participants reported “liking” the intervention, only one participant (P315) agreed to continue the study for 2 additional weeks. P315’s steps continued to increase during the 2 weeks.

Recruiting participants from the community proved difficult. We spent several months distributing flyers in the community (e.g., coffee shops, restaurants, churches, schools) and placing Facebook ads online. Ultimately, however, no participants were recruited through those
means. This might have been due to the vague nature of the flyers and Facebook advertisements. All participants were recruited through word of mouth. It is possible that the intervention is simply unappealing to people and, therefore, people chose not to participate. Another possibility is that the $42 deposit was too high for some participants while others might have found it not high enough. We suggest two potential solutions to the difficulties of recruitment. First, future research should put more emphasis on the potential to earn more than what is individually deposited. Second, researchers might use a sliding scale, where participants can decide how much to deposit (e.g., John et al., 2011).

When developing interventions that clinicians can feasibly implement, the response effort of researchers (and future clinicians) should be considered. In the current study, the researcher spent time creating program materials (e.g., excel spreadsheets to track goals and steps), approximately 4 months recruiting, creating and editing daily prize-draw videos, meeting with participants, communicating goals, verifying earnings, and troubleshooting technical issues. Future efforts might reduce the time and energy required to implement the intervention by creating software applications to automate feedback, prize draws, goal setting, and goal tracking. Developing a user-friendly interface might also reduce the time and effort required by participants (e.g., watching videos, tracking goals and earnings). Although developing such software would be labor intensive upfront, automated programs would be more easily scalable; that is, each additional participant would not result in much more work for the researcher or clinician.

A strength of this study was that technology allowed for a primarily web-based intervention. Participants visited the research lab only twice, once to deposit $42 in cash and obtain the Fitbit, and once to collect their earnings and return the Fitbit. (It was determined that
cash would be used to comply with University compensation policies.) Height and weight measures were recorded during both lab visits, as well. All prize drawings, communication, and data collection were completed via mobile technology (i.e., smart phones, Fitbit Zips). Future researchers could easily ship Fitbits to the participants and use online services such as PayPal for deposits and payouts (e.g., Kurti & Dallery, 2013). Technologies like the Fitbit lower the response requirement for participating in this type of intervention and increase the objectivity and reliability of response measurement. This might improve social and internal validity of such interventions compared to interventions that use other technologies (e.g., pedometers) or rely on self-monitoring and self-report.

The intervention resulted in increased step counts for four of six participants. This approximates findings reported from similar CM studies targeting PA (Andrade, Barry, & Byrne, 2013; Kurti & Dallery, 2013; Washington et al., 2014; Washington et al., 2016). Conclusions about the effects of the intervention are strengthened by the longer baselines of this study. Washington et al. (2014) suggested using longer baselines to obtain stable baseline data before introducing the CM intervention. Our baseline followed this suggestion with a 12-day baseline period. A steady-state baseline strengthens baseline-to-intervention comparisons. That is, when steady-state baselines are observed, changes from baseline to intervention are more likely due to the independent variable and not due to factors such as participants becoming acclimated to the pedometers (Sidman, 1960).

One important point to note is that the mean daily step-counts of P313 and P317 during baseline were high (8,735 and 9,636, respectively) compared to the average American who takes 5,117 steps per day (Bassett, Wyatt, Thompson, Peters, & Hill, 2010). Originally, we planned on excluding any participant who exceeded 6,000 steps per day, on average, during baseline.
However, due to the difficulty in recruiting participants from the community, we decided to keep the participants in the study. Although P313 did not take more steps during intervention, suggesting a potential ceiling effect, P317 did consistently meet her goals during intervention. By the end of intervention P317’s goal was set at 14,601 steps and, during the final week of intervention, she took an average of 15,395 steps per day.

One often identified limitation to CM interventions is the lack of maintenance (Andrade, Barry, Litt, & Petry, 2014; Butryn, Webb, & Wadden, 2011; Jeffery, 2012; John et al., 2011; Silverman, Roll, & Higgins, 2008). The current study did not evaluate whether intervention effects persisted. A group-deposit prize draw might easily be arranged to include a schedule thinning component, which have shown some promise at maintaining PA (Andrade et al., 2014). Similar to other studies that use reversal designs, steps did not maintain during the return to baseline (Washington et al, 2014; Washington et al, 2016). Because PA-related illness are “chronic” in nature, “chronic” solutions might be required if we are to meaningfully address these challenges (McLellan, 2015).

Participants reported a wide range of events as factors that hindered their daily goal achievement. Reasons included physiological events (e.g., ankle injury), family events (e.g., daughter moving out to college), or challenges with depression. The extent to which the reported events did or did not affect PA is unknown, but we did get the sense that even seemingly insignificant events likely had impacts on participant motivation and behavior. Clinicians would do well to listen to the concerns of participants and provide flexible intervention alternatives in case unexpected events occur (e.g., sickness). For example, Kurti and Dallery (2013) allowed two days per 5-day bin that participants could use if they needed a break from physical activity. Reinforcement occurred if a participant met the goal 3 out of 5 days, and new goals were sent
every 5 days. For many, being more physically active is difficult and there are many important and potentially overlooked factors that can impede their progress.

We did not reinforce PA that simply exceeded the 10,000-step recommendation. However, the United States Department of Health and Human Services (USDHHS, 2018) states that any physical activity over the recommended amount results in even greater benefits. Therefore, it might be beneficial for participants who are meeting the 10,000-step recommendation (e.g., P313, P317, and P318) to earn additional draws for engaging in even higher levels of PA. One strategy that can reinforcer higher step-counts is an escalating schedule of reinforcement. Kurti & Dallery (2013) used an escalating schedule of reinforcement to reinforce increased step counts ($3.00 for 3,000-3,999 steps, $4.00 for 4,000-4,999 steps, and so on). Moreover, escalating schedules have been shown to be more efficacious than other reinforcement schedules (Roll, Huber, Sodano, Chudzynski, Moynier, & Shoptaw, 2006). In the current study, escalating schedules were avoided to limit costs; however, $124 was left in the prize bowl at the end of the intervention. Future research could use these funds to support an escalating schedule for exceeding 10,000 steps per day (e.g., met step goals between 0 and 10,000 steps earns one draw, and met step goals >10,000 earns two prize draws).

One variable that might have influenced the participants’ PA was that researchers did not describe the actual probabilities and distribution of prize-draw ticket values to the participants. Instead, participants were told, “Half the tickets are winners. Of winning tickets, some are small in value, some are medium in value, and some are large in value. There is a small chance to earn a large-value ticket and a high chance to earn a small-value ticket.” Washington et al. (2014) did not reveal the actual probabilities of prize draws, but they did show the participants the prizes they could earn. Future research might more explicitly describe the exact ticket probabilities and
magnitudes prior to intervention. This information might serve as a motivating operation that increases the effectiveness of the prize draws.

To our knowledge, this is the first intervention that combines a lottery system with a deposit contract. Besides the cost of the Fitbits, the group-deposit prize-draw was a relatively inexpensive intervention to administer. Furthermore, this is one of the first deposit contract interventions that did not match the deposits of the participants (e.g., John et al., 2011; Washington et al., 2016). The combination of a deposit contract and a lottery, along with the omission of a matched deposit, resulted in a low-cost intervention that might be more financially sustainable than other types of CM interventions. The extent to which this is true will need to be established by future research.

Clinicians might consider following this CM model or other variations of deposit contracts (e.g., sliding scales) and prize-based CM (e.g., increase the distribution of winning tickets) to maintain or improve effects while curbing costs. It should be noted that our lab provided the Fitbits to the participants. Fitbits were returned at the end of the study to be used in future research. Future research might use unearned deposits to cover the costs of lost or new Fitbits, or as reimbursement to clinical staff.

Fitbits, and pedometers more generally, are a cost-effective tool for measuring PA, but they have several limitations. First, it is difficult to verify that the steps being counted are taken by the participant. Some solutions have been suggested, but affordable commercial products are not yet available (see Cornelius & Kotz, 2010, for a review). Second, participants can cheat by moving or shaking the pedometer, resulting in steps being counted that they did not actually take. Third, not all kinds of movement (e.g., swimming, cycling) are tracked by a pedometer. Fourth, recommendations are based on intensity of physical activity (USDHHS, 2018) and pedometers
only measure hip displacement. As costs become more affordable, researchers should consider using heart rate monitors. Then, goals could be set to have a certain duration in elevated heart-rate zones. Not only would intensity and cheating be addressed, other PA (e.g., cycling) would be more accurately recorded. Increasing the range of behaviors that are reinforced might result in improved social validity.

In 1976 Montrose Wolf argued for the increased use of social validity measures in behavioral research. Wolf argued that nonpreferred interventions will likely be avoided (Wolf, 1978). For the last 40 years, behavior analysts have questioned the accuracy of social validity measures and urged the development of improved measures (Carr et al., 1999; Ferguson et al., 2018; Kennedy, 1992; Wolf, 1978). Hanley (2010) argues that behavioral interventions might become more adoptable if developed with an objective social validity measure such as consumer choice, instead of inferring consumer preference. In the current study, social validity was assessed by giving participants the option to continue in the study for two weeks. Even with very high favorability ratings from all participants, only one participant elected to participate in an additional 2 weeks of intervention. Similar studies either reported high favorability ratings (Kurti & Dallery; 2013) or did not report social validity (Petry, et al., 2013; Washington et al., 2014; Washington et al., 2016). Moreover, no similar studies reported a choice option to assess social validity. While our social validity measure was a strength of the study, the fact that only one participant elected to continue with the intervention should be seen as a weakness of the intervention. That the other participants did not elect to continue the intervention suggests that, although they rated it favorably, they would be unlikely to use it. Future research should include similar behavioral measures of social validity as social validity is most likely a factor influencing clinical adoption (Wolf, 1978).
Although the initial purpose of the study was to assess the feasibility of a low-cost CM arrangement, results of the study indicate that social validity should be a primary focus of future research. Improvements might be made by referring to commercial products like stickK (2019), DietBet (2019), or StepBet (2019). Data on the effectiveness of these and similar products have not been published, but such products offer various services that researchers might use to improve social validity and appeal for potential participants. For example, in some programs, unearned deposits are donated to a charity, a friend, or a nonpreferred organization. Additionally, StickK.com and StepBet incorporate a community forum in which users can encourage each other to meet their goals. Also, these commercial programs use larger groups that can result in larger monetary payouts. In the current study, the average total payout was $21. Larger magnitude payouts, like those reported by DietBet (e.g., $1,000 or more), might result in larger effects, higher levels of participation, and improved social validity.

Another potential variable that might have decreased social validity is the type of interactions with researchers. For example, P313 requested that the researcher not use the word “unfortunately” when discussing a missed goal. In response, we revised the feedback to focus on more positive words (i.e., “Today is a new day to meet your goal!”). This is important, as, for example, Chadwell, Sikorski, Roberts, and Allen (2018) found that families preferred clinicians that have therapeutic skills (e.g., relatability, listening skills) even at the expense of intervention efficacy. Moreover, other research suggests that matching clients to preferred treatments and therapists results in decreased dropout rates and increased outcomes (e.g., Swift, Callahan, & Vollmer, 2010).

The goal of our study was to establish a cost-effective intervention that might prove feasible to implement in community settings. This study established a novel and relatively
inexpensive intervention for increasing PA for four of six adults. However, challenges with recruitment, and the lack of participants volunteering for the additional two weeks suggests dissemination efforts might be precluded by lack of social validity.
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APPENDIX A: THESIS PROPOSAL INTRODUCTION

The World Health Organization (WHO, 2016) reports that 3.2 million deaths per year are attributable to physical inactivity, making it the fourth leading risk factor for global mortality. Physical inactivity also is a key risk factor for noncommunicable diseases such as cardiovascular disease, cancer, and diabetes (WHO, 2017). Globally, 1 in 4 adults is not active enough and, therefore, foregoes a myriad of health benefits associated with PA (WHO, 2016). In the United States, only about 1 in 5 (21%) adults meet the 2008 Physical Activity Guidelines set by the Centers for Disease Control and Prevention (CDC, 2014). The CDC currently recommends adults engage in 150 min of moderate-intensity aerobic activity per week (CDC, 2017). Translated to steps, the recommendation can be met by taking 3,000 steps in 30 min, 5 days per week (Marshall et al., 2009). Physical inactivity also is a major contributor to obesity (WHO, 2016). According to the WHO, worldwide prevalence of obesity more than doubled between 1980 and 2014 (WHO, 2016). In the United States, the medical costs of obesity were estimated to be $147 billion, or 10% of all medical spending (Finkelstein, Trogdon, Cohen, & Dietz, 2009).

To combat the many problems associated with physical inactivity, the CDC (2015), the WHO (2016), and the American Heart Association (AHA; 2016) prescribe increased PA. Furthermore, increased PA contributes to a variety of other health benefits, including a decreased risk for cardiovascular disease, type 2 diabetes, some cancers, as well as improved mental health, and increased life expectancy (CDC, 2015).

It is clear that developing interventions to increase PA is of utmost importance. One promising intervention strategy is Contingency Management (CM), in which a target behavior is measured, tangible reinforcers are delivered if the target behavior occurs, and reinforcement is
withheld if the target behavior does not occur (Petry, 2000). CM is based on the operant conditioning principle of reinforcement, whereby a consequence follows a behavior and increases the future likelihood of that behavior (Silverman, Jarvis, Jessel, Lopez, 2016). CM was developed to address overeating (Stuart, 1967), but researchers have since used CM to address a host of health challenges (e.g., drug use, treatment adherence, therapy attendance). One of the earliest forms of CM used vouchers instead of money as reinforcement, because vouchers decrease the likelihood that participants can purchase items related to problem behavior, (e.g., buying cigarettes during a smoking cessation intervention; Petry, 2000). CM has been shown to be an effective intervention for a variety of problems including alcohol abuse (e.g., Miller, 1975; Petry, Martin, Cooney, & Kranzler, 2000), smoking cessation (Alessi, Petry, & Urso, 2008; Cahill, Hartmann-Boyce, Perera, 2015; Dallery, Raiff, & Grabinski, 2013; Dunn et al., 2008), therapy attendance (Carey & Carey, 1990; Chaisson et al., 1996; Stevens-Simon et al., 1997), work attendance (e.g., Silverman et al., 1996b), and obesity and weight loss (see Jeffery, 2012, for a review). The accumulation of evidence that CM interventions are effective resulted in CM being identified by the United Kingdom’s National Institute for Health and Clinical Excellence as one of the most effective psychosocial interventions for drug abuse (Pilling, Strang, & Gerada, 2007), specifically opioid abstinence (Bickel et al., 1997; Stitzer et al., 1980) and cocaine abstinence (Higgins et al., 1993; Silverman et al., 1996a).

CM interventions have been demonstrated effective for addressing obesity, with many health researchers focusing on weight loss as a dependent variable; however, there are two concerns with doing so. First, weight loss can be the product of a variety of behaviors, both appropriate and inappropriate. For example, Mann (1972) provided reinforcement contingent on weight loss and participants reported engaging in a variety of inappropriate behaviors (i.e., taking
laxatives, diuretics, or doing vigorous exercises) just prior to weigh-ins to reach their weight loss goals. Second, overall health can improve while weight remains unchanged (i.e., increased muscle density with decreased body fat; see Lee, Sui, & Blair, 2008, for a review; Paffenbarger, Hyde, Wing, & Hsieh, 1986; or improved cardiovascular health independent of weight loss (Burstein, Epstein, Shapiro, Charuzi, & Karnieli, 1990; Kenney & Seals, 1993; Wei et al., 1999). As such, targeting PA instead of weight loss might prove a better approach for improving health. More recently, research has focused on increasing healthy behaviors that are directly measured, such as PA (Kurti & Dallery, 2013; Patel et al., 2016; Washington, Banna, & Gibson, 2014; Washington, McMullen, Devoto, 2016). Although studies have shown the potential of CM to change behavior, researchers report that clinical adoption continues to be minimal due, at least in part, to the cost of CM interventions (Dallery, Meredith, & Glenn, 2008; Petry, 2000; Silverman, Roll, & Higgins, 2008).

Costs Associated with Contingency Management Interventions

CM interventions are effective, but come at a cost. Clinicians have identified these costs as a primary barrier to clinical adoption (Kirby, Benishek, Dugosh, & Kerwin, 2006). The initial CM intervention using vouchers cost an average of $600 per participant (Higgins et al., 1993), and some voucher interventions cost as much as $3480 per participant (e.g., Silverman, Chutuape, Bigelow, & Stitzer, 1999). Petry (2000) also noted the overlooked costs of personnel required to run these programs (e.g., urine testing, running prize draws, picking up prizes to be raffled). One potentially cost-effective rendition of CM is the therapeutic workplace where drug abstinence is reinforced with employment; however, this model still is supported by large grants from the National Institute on Drug Abuse (Silverman et al., 2007). Lastly, some researchers have suggested that community clinics will find it difficult to adopt interventions for which the
costs are not reimbursed by insurance providers or federal programs (Roll, Madden, Rawson, & Petry, 2009).

Decreasing costs of CM interventions while maintaining effectiveness and acceptability has been a focus of CM researchers for many years (see Jeffery, 2012, and Petry, 2000, for a review). On the one hand, higher payouts improve the effectiveness, but increase the financial costs, of CM interventions (Sindelar, Elbel, & Petry, 2007). On the other hand, decreased payouts of CM interventions reduces efficacy (Petry et al., 2004). Recent attempts have been made to develop interventions that decrease costs without compromising effectiveness. Two CM interventions have been identified for their cost-saving potential: prize-based CM and deposit contracts. Prize-based CM interventions were developed to address cost and maintenance concerns (Petry et al., 2000) while deposit contracts were initially developed to address smoking cessation (Elliott & Tighe, 1968), but later identified for their potential to minimize costs (Dallery et al., 2008).

**Prize-Based Contingency Management**

Prize-based CM emerged out of a concern about the costs of voucher-based interventions, and researchers have been able to decrease associated CM costs without compromising effectiveness. Prize-based procedures have been shown effective in treating cocaine addiction (Petry, et al., 2004), alcohol abstinence (Petry, et al., 2000), smoking cessation (Alessi, Petry, & Urso, 2008; Ledgerwood, Arfken, Petry, & Alessi, 2014), promoting weight loss (Petry, Barry, Pescatello, & White, 2011), and increasing PA (Washington, Banna, & Gibson, 2014). A practical benefit of the prize-based procedure is that behavior that meets the response criteria will be reinforced variably, resulting in reduced payouts during intervention.
Petry et al. (2000) were the first to evaluate the effects of a prize-based CM intervention to treat alcohol dependence. The prize-based group earned draws from the prize bowl contingent on submitting a breathalyzer sample that tested negative for alcohol. Tickets in the bowl were small (e.g., $1 coupons to McDonalds), medium (e.g., gift certificates to a movie theatre), and large (e.g., handheld television) in value. After 8 weeks, the prize-based intervention plus standard treatment produced more drug-free urine samples (e.g., alcohol, opiates, cocaine) and better retention rates than standard treatment alone (i.e., only 22% of participants remained from the standard-treatment group, compared to 84% from the prize-based group). Although this study did not directly compare the prize-based intervention with voucher programs, it is important to note the significant cost savings of the prize-based intervention compared to typical voucher programs, which at the time of the study were the most popular form of CM. The participants earned an average of $200 worth of prizes per participant in the Petry et al. (2000) study compared to $600 per participant in traditional voucher programs (e.g., Higgins et al., 1993).

Other researchers have used prize-based interventions targeting different dependent variables while improving the cost efficiency of the prize-based intervention used by Petry et al. (2000). For example, Alessi et al. (2008) decreased cigarette smoking by adults in a residential drug treatment facility, with an average cost per participant of $157 using a progressive schedule of reinforcement with a reset for relapse. At the conclusion of the 12-week study, the results showed that prize-based intervention was better at decreasing smoking in a difficult-to-treat population compared to standard treatment (i.e., individual and group therapy, job search or employment after 30 days, random drug tests, and merit-based privileges). With costs kept at $162 per participant and weight loss as the dependent variable, Petry et al. (2011) found that
individuals who participated in the prize-based intervention lost more weight than those who experienced 30-45 min counseling sessions.

With respect to PA, Washington and colleagues (2014) used a prize-based intervention to increase step counts, with a cost of $12.60 per participant ($126 for 10 participants) for the duration of the 3-week study. Participants earned the opportunity to draw a prize if they met a specified step criterion. Step criteria were determined based on a percentile schedule of reinforcement whereby step counts from the previous 7 days were rank-ordered, with the participant needing to exceed the steps from the 5th highest day. Results showed that the prize-based intervention was a cost-effective way to increase PA. Although there were increased step counts during intervention, no maintenance data were collected. Even though researchers have gradually decreased implementation costs, the authors noted that this is not a sustainable long-term intervention as researchers will not have the money to fund prize-based interventions continually. The authors suggested that future research should assess the effectiveness of deposit contracts alongside prize-based interventions, as the literature on deposit contracts suggests increased savings and effects might be achieved by combining the two interventions.

**Deposit Contracts**

The deposit contract is another low-cost form of CM. Deposit contracting is a procedure in which participants deposit money at the beginning of a study that can be earned back during the CM intervention based on goal attainment, with participants thereby funding their own payouts (Silverman, Roll, & Higgins, 2008). One criticism of deposit contracts is that participants are asked to pay to take part in scientific research; however, people regularly pay for programs (e.g., gym memberships, Jenny Craig, Weight Watchers) that promise to increase PA but have little or no empirical basis. A preferable alternative might be an intervention that
measurably increases healthy behavior while decreasing costs to participants. Researchers have used deposit contracts to be address various behaviors with a focus on effectiveness and lowering costs to both researchers and participants. This has resulted in an economically promising intervention.

Dallery et al. (2008) found that deposit contracts were feasible and as effective as researcher-funded payouts for promoting smoking cessation. Eight smokers were randomized into two groups: deposit and no-deposit. All participants were exposed to the CM intervention in which participants earned vouchers that could be exchanged for items contingent on reductions in carbon monoxide levels. Reinforcement was based on a progressive schedule of reinforcement with a reset if relapse occurred. Participants earned $0.50 for the initial goal achievement and an added $0.10 (total $0.60) each consecutive day they achieved their goal. If a participant relapsed, the payout was reset to $0.50. A $3.00 bonus was earned every third consecutive day that behavior met criterion. The only difference between the groups was that individuals in the deposit group were required to provide a $50 deposit. Results indicated that only one participant from the study returned to baseline levels of smoking during the return to baseline, whereas all other subjects from both groups had decreased carbon monoxide levels during the return to baseline. Overall, the participant-funded intervention was as effective as the researcher-funded intervention. However, the deposit group resulted in a surplus of funds, which were used to supplement the costs of the no-deposit group. This study was one of the initial studies to compare a deposit contract with a traditional CM intervention and it demonstrated that effectiveness was not lost by having participants fund their own payouts.

Volpp et al. (2008) reported that deposit contracting promoted weight loss as well as prize-based reinforcement. Fifty-seven obese individuals were randomly assigned to three
intervention groups: typical treatment (monthly weigh-ins), prize-based CM, and deposit contract. Daily weight goals were to lose 1 lb per week (16 lb over 16 weeks). Results showed that incentive-based interventions (prize-based and deposit contracts) both promoted similar weight loss and that both were more effective than typical treatment. Participants were asked to contribute $0.00 - $3.00 per month across 4 months of intervention, with the total cost per participant being $378 in the deposit group and $273 in the prize-based group. (Costs were higher in the deposit group because researchers matched the amount deposited by participants.) An 8-month follow-up showed considerable weight regain had occurred for all groups. Because deposits were matched by the researchers (i.e., participants could double the money they deposited), the conclusions that can be made about the effectiveness of the deposit group are limited, insofar as the participants did not fund the entire payout. Still, although deposits were matched, the financially more sustainable intervention was as effective as the researcher funded intervention.

Another study directly compared standard CM interventions to deposit contracts and showed that deposit contracts increased PA as well as the standard CM intervention did (Washington, McMullen, & Devoto, 2016). Nineteen participants who took fewer than 10,000 steps during a 1-week baseline were randomly assigned to a deposit or a no-deposit group. Participants in the deposit group were required to deposit $25. All participants earned $1.50 for each day that a step goal was met across 21 days of intervention, with step goals determined using a percentile schedule of reinforcement (Galbicka, 1994). The deposit contract increased step counts as much as standard CM; however, the authors were concerned that the deposit might negatively affect acceptability to college students so they matched the deposits of the of deposit
group. (The cost to researchers for the deposit group was $0.48 per participant.) This resulted in participants potentially earning more than they deposited. The matched deposit limits the conclusions that can be drawn about the effectiveness of the deposit group because the researchers subsidized payouts.

Patel et al. (2016) compared three CM interventions (i.e., lottery, loss incentive, gain incentive) in terms of increasing PA. Patel et al. did not match deposits, and showed a loss-incentive group (deposit-contract group) to be more effective than standard CM interventions. However, the loss-incentive group was not a true deposit contract because participants were given the initial $42 at the start of the study which they lost if they failed to meet their daily step goals. Although a true deposit was not used, this study adds to the growing evidence establishing the feasibility and cost-effectiveness of the deposit contract without researchers matching the deposit.

**Maintenance**

Despite the successful use and continued decrease in cost requirements of CM interventions to treat drug addiction, weight loss, and other behavior problems, the lack of long-term maintenance has been identified as a primary limitation of such interventions (Andrade, Barry, Litt, & Petry, 2014; Butryn, Webb, & Wadden, 2011; Jeffery, 2012; John et al., 2011; Silverman, Roll, & Higgins, 2008). Alamuddin and Wadden (2016) recently recommended that future research focus on improving the long-term maintenance of weight loss and PA. Although some research has addressed the maintenance of weight loss (Jeffery et al., 2000; John et al., 2011) and drug abstinence (see Benishek et al., 2014, for a review), such studies are relatively rare and have produced only modest results (National Institute on Drug Abuse, 2012).
Presumably, clinicians might be more inclined to implement CM interventions if they have demonstrated long-term effectiveness.

Stokes and Baer (1977) identified the lack of maintenance of behavioral interventions as a problem that goes overlooked by behavior analysts and described a variety of recommendations for addressing maintenance. One promising recommendation that might prove beneficial for maintaining PA is to use “indiscriminable contingencies,” or unpredictable contingencies where participants do not know when reinforcement will be produced. Ferster & Skinner (1957) reported that intermittent schedules of reinforcement produced more persistent responding compared to continuous schedules. Ferster and Skinner (1957) define an intermittent schedule as “a contingency of reinforcement in which some, but not all, occurrences of the behavior produce reinforcement” (p. 698). In terms of CM, prize-based intervention approximates an intermittent schedule of reinforcement such that participants earn the opportunity to draw tickets out of a prize bowl for meeting specified goals. Half of the tickets are praise only (e.g., “Great Job!”), the other half have monetary value; therefore, participants will not receive monetary reinforcement for every instance or bout of behavior. Monetary reinforcement is based on the participant 1) meeting criteria and 2) drawing a winning ticket (i.e., 50% of tickets are praise only). This means participants will have the chance to earn money on every draw, but are not guaranteed a winning ticket for goal achievement. The prize bowl contains many smaller-value tickets and fewer larger-value tickets; for example, if there is a total of 250 tickets, 125 might be $1, and 1 ticket might be worth $100 (Petry, 2008). It should be noted that praise-only draws could function as reinforcement; however, previous research has shown a positive relationship between payout magnitude and the magnitude of intervention effects (Sindelar et al., 2007). As such, praise-only draws might have minimal or no effect on
behavior because of they have no monetary value. Additionally, the praise-only draw could be a non-preferred consequence given that participants have the chance to win $100. The financial consequence of failing to achieve a goal and drawing a praise-only ticket will be the same. Whether praise draws will function as reinforcers that produce meaningful behavior change remains an empirical one.

**Purpose**

A myriad of health challenges could be addressed by increasing PA. Two CM interventions have shown promise in addressing physical inactivity at relatively low cost. First, prize-based reinforcement has been shown to increase PA and minimize costs by using intermittent, rather than continuous, reinforcement. Second, deposit contracts have increased PA and minimized costs by using participants’ money to fund interventions. However, maintenance of PA and limited clinical adoption continue to be challenges. Therefore, developing financially sustainable interventions might promote wider clinical adoption.

The proposed study will examine the effects of a prize-based intervention funded by pooling participants’ deposits on individuals’ steps counts. Combining the two procedures has multiple potential benefits: First, pooling the deposits from all participants into one prize bowl will increase the magnitude of reinforcement available for each participant, with larger magnitude reinforcers being correlated with improved intervention effects (Silverman et al., 1996; Sindelar et al., 2007). This gives participants the chance to earn more than they initially deposit. Second, both deposit contracts and prize-based reinforcement procedures were developed to make CM more financially feasible, and combining these strategies might make CM even more cost-effective, thereby increasing clinical utility and perhaps leading to wider adoption. Third, the group deposit-contract prize draw would result in a variable schedule of
reinforcement, which is a strategy that has been recommended to improve long-term outcomes of behavioral interventions (Stokes & Baer, 1977).
References


doi:10.1152/jappl.1990.69.1.299


Centers for Disease Control and Prevention (2015). How much physical activity do adults need?  


APPENDIX B: PAR-Q+

CSEP approved Sept 12 2011 version

PAR-Q+
The Physical Activity Readiness Questionnaire for Everyone

Regular physical activity is fun and healthy, and more people should become more physically active every day of the week. Being more physically active is very safe for MOST people. This questionnaire will tell you whether it is necessary for you to seek further advice from your doctor OR a qualified exercise professional before becoming more physically active.

SECTION 1 - GENERAL HEALTH

Please read the 7 questions below carefully and answer each one honestly: check 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
5. Are you currently taking prescribed medications for a chronic medical condition? YES NO
6. Do you have a bone or joint problem that could be made worse by becoming more physically active? YES NO
   Please answer NO if you had a joint problem in the past, but it does not limit your current ability to be physically active. For example, knee, ankle, shoulder or other.
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.

Go to Section 3 to sign the form. You do not need to complete Section 2.

Delay becoming more active if:

- You are not feeling well because of a temporary illness such as a cold or fever – wait until you feel better
- You are pregnant – talk to your health care practitioner, your physician, a qualified exercise professional, and/or complete the PARmed-X for Pregnancy before becoming more physically active OR
- Your health changes – please answer the questions on Section 2 of this document and/or talk to your doctor or qualified exercise professional (CSEP-CEP or CSEP-CPT) before continuing with any physical activity programme.

If you answered YES to one or more of the questions above, please GO TO SECTION 2.
### SECTION 2 - CHRONIC MEDICAL CONDITIONS

Please read the questions below carefully and answer each one honestly: check YES or NO.

<table>
<thead>
<tr>
<th></th>
<th>YES</th>
<th>NO</th>
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</thead>
<tbody>
<tr>
<td>1. Do you have Arthritis, Osteoporosis, or Back Problems?</td>
<td>If yes, answer questions 1a-1c</td>
<td>If no, go to question 2</td>
</tr>
<tr>
<td>1a. 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)</td>
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<td>1b. Do you have joint problems causing pain, a recent fracture or 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)?</td>
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<td>1c. Have you had steroid injections or taken steroid tablets regularly for more than 3 months?</td>
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<tr>
<td>2. Do you have Cancer of any kind?</td>
<td>If yes, answer questions 2a-2b</td>
<td>If no, go to question 3</td>
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<tr>
<td>2a. Does your cancer diagnosis include any of the following types: lung/bronchogenic, multiple myeloma (cancer of plasma cells), head, and neck?</td>
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<td>2b. Are you currently receiving cancer therapy (such as chemotherapy or radiotherapy)?</td>
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<tr>
<td>3. Do you have Heart Disease or Cardiovascular Disease? This includes Coronary Artery Disease, High Blood Pressure, Heart Failure, Diagnosed Abnormality of Heart Rhythm</td>
<td>If yes, answer questions 3a-3e</td>
<td>If no, go to question 4</td>
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<tr>
<td>3a. 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)</td>
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<td>3b. Do you have an irregular heart beat that requires medical management? (e.g. atrial fibrillation, premature ventricular contraction)</td>
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<td>3c. Do you have chronic heart failure?</td>
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<tr>
<td>3d. 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)</td>
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<td>3e. Do you have diagnosed coronary artery (cardiovascular) disease and have not participated in regular physical activity in the last 2 months?</td>
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<td>4. Do you have any Metabolic Conditions? This includes Type 1 Diabetes, Type 2 Diabetes, Pre-Diabetes</td>
<td>If yes, answer questions 4a-4c</td>
<td>If no, go to question 5</td>
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<tr>
<td>4a. Is your blood sugar often above 13.0 mmol/L? (Answer YES if you are not sure)</td>
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<td>4b. Do you have any signs or symptoms of diabetes complications such as heart or vascular disease and/or complications affecting your eyes, kidneys, and the sensation in your toes and feet?</td>
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<td>4c. Do you have other metabolic conditions (such as thyroid disorders, pregnancy-related diabetes, chronic kidney disease, liver problems)?</td>
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<td>5. 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)</td>
<td>If yes, answer questions 5a-5b</td>
<td>If no, go to question 6</td>
</tr>
<tr>
<td>5a. 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)</td>
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<tr>
<td>5b. Do you also have back problems affecting nerves or muscles?</td>
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</table>
Please read the questions below carefully and answer each one honestly: check YES or NO. 

<table>
<thead>
<tr>
<th><strong>6. Do you have a Respiratory Disease? This includes Chronic Obstructive Pulmonary Disease, Asthma, Pulmonary High Blood Pressure</strong></th>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>6a. 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)</td>
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<tr>
<td>6b. Has your doctor ever said your blood oxygen level is low at rest or during exercise and/or that you require supplemental oxygen therapy?</td>
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<td>6c. If asthmatic, do you currently have symptoms of chest tightness, wheezing, laboured breathing, consistent cough (more than 2 days/week), or have you used your rescue medication more than twice in the last week?</td>
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<td>6d. Has your doctor ever said you have high blood pressure in the blood vessels of your lungs?</td>
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</table>

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<thead>
<tr>
<th><strong>7. Do you have a Spinal Cord Injury? This includes Tetraplegia and Paraplegia</strong></th>
<th>If yes, answer questions 7a-7c</th>
<th>If no, go to question 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>7a. 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)</td>
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<tr>
<td>7b. Do you commonly exhibit low resting blood pressure significant enough to cause dizziness, light-headedness, and/or fainting?</td>
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<tr>
<td>7c. Has your physician indicated that you exhibit sudden bouts of high blood pressure (known as Autonomic Dysreflexia)?</td>
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<tr>
<th><strong>8. Have you had a Stroke? This includes Transient Ischemic Attack (TIA) or Cerebrovascular Event</strong></th>
<th>If yes, answer questions 8a-c</th>
<th>If no, go to question 9</th>
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</thead>
<tbody>
<tr>
<td>8a. 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)</td>
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<tr>
<td>8b. Do you have any impairment in walking or mobility?</td>
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<tr>
<td>8c. Have you experienced a stroke or impairment in nerves or muscles in the past 6 months?</td>
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<tr>
<th><strong>9. Do you have any other medical condition not listed above or do you live with two chronic conditions?</strong></th>
<th>If yes, answer questions 9a-c</th>
<th>If no, read the advice on page 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>9a. 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?</td>
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<tr>
<td>9b. Do you have a medical condition that is not listed (such as epilepsy, neurological conditions, kidney problems)?</td>
<td></td>
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<tr>
<td>9c. Do you currently live with two chronic conditions?</td>
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</table>

Please proceed to Page 4 for recommendations for your current medical condition and sign this document.
PAR-Q+

If you answered NO to all of the follow-up questions about your medical condition, you are ready to become more physically active:

› It is advised that you consult a qualified exercise professional (e.g., a CSEP-CEP or CSEP-CPT) to help you develop a safe and effective physical activity plan to meet your health needs.
› You are encouraged to start slowly and build up gradually – 20-60 min. of low- to moderate-intensity exercise, 3-5 days per week including aerobic and muscle strengthening exercises.
› As you progress, you should aim to accumulate 150 minutes or more of moderate-intensity physical activity per week.
› If you are over the age of 45 yrs. and NOT accustomed to regular vigorous physical activity, please consult a qualified exercise professional (CSEP-CEP) before engaging in maximal effort exercise.

If you answered YES to one or more of the follow-up questions about your medical condition:
› You should seek further information from a licensed health care professional before becoming more physically active or engaging in a fitness appraisal and/or visit a or qualified exercise professional (CSEP-CEP) for further information.

Delay becoming more active if:
› You are not feeling well because of a temporary illness such as a cold or fever – wait until you feel better
› You are pregnant - talk to your health care practitioner, your physician, a qualified exercise professional, and/or complete the PARmed-X for Pregnancy before becoming more physically active OR
› Your health changes - please talk to your doctor or qualified exercise professional (CSEP-CEP) before continuing with any physical activity programme.

SECTION 3 - DECLARATION

› You are encouraged to photocopy the PAR-Q+. You must use the entire questionnaire and NO changes are permitted.
› The Canadian Society for Exercise Physiology, the PAR-Q+ Collaboration, and their agents assume no liability for persons who undertake physical activity. If in doubt after completing the questionnaire, consult your doctor prior to physical activity.
› If you are less than the legal age required for consent or require the assent of a care provider, your parent, guardian or care provider must also sign this form.

Please read and sign the declaration below:

I, the undersigned, have read, understood to my full satisfaction and completed this questionnaire. I acknowledge that this physical activity clearance is valid for a maximum of 12 months from the date it is completed and becomes invalid if my condition changes. I also acknowledge that a Trustee (such as my employer, community/fitness centre, health care provider, or other designate) may retain a copy of this form for their records. In these instances, the Trustee will be required to adhere to local, national, and international guidelines regarding the storage of personal health information ensuring that they maintain the privacy of the information and do not misuse or wrongfully disclose such information.

NAME ____________________________________________________ DATE _________________________________________

SIGNATURE _____________________________________WITNESS _________________________________________________

SIGNATURE OF PARENT/GUARDIAN/CARE PROVIDER _________________________________________________________

For more information, please contact:
Canadian Society for Exercise Physiology
www.csep.ca

KEY REFERENCES

The PAR-Q+ was created using the evidence-based AGREE process (1) by the PAR-Q+Collaboration chaired by Dr. Darren E. R. Warburton with Dr. Norman Gledhill, Dr. Veronica Jamnik, and Dr. Donald C. McKenzie (2). Production of this document has been made possible through financial contributions from the Public Health Agency of Canada and the BC Ministry of Health Services. The views expressed herein do not necessarily represent the views of the Public Health Agency of Canada or BC Ministry of Health Services.
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<td></td>
<td>Question</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Undecided</td>
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<td>3</td>
</tr>
</tbody>
</table>
APPENDIX D: DEMOGRAPHICS QUESTIONNAIRE

Participant #: ____________

Demographic Questionnaire

Age: _______________________

Sex: ______________

Ethnicity (Please check all that apply):
- American Indian/Alaska Native
- Asian
- Black/African American
- Hispanic
- Native Hawaiian/Other Pacific Islander
- White
- Other: _______________________

What is your income?
- $0 - $25,000
- $26,000 - $50,000
- $51,000 - $75,000
- $76,000 - $100,000
- $101,000 - $125,000
- $126,000 - $150,000

Height: __________

Weight: __________
**APPENDIX E: SOCIAL VALIDITY SURVEY**

Participant #: ______________________  Date: _______ / ______ / ______

**Social Validity Survey**

<table>
<thead>
<tr>
<th>1. Would you like to continue in the study for an additional 2 weeks?</th>
<th>YES</th>
<th>NO</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. The deposit amount ($42) was too high.</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
</tr>
<tr>
<td>3. The was experience worth the money.</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>4. The daily reminders via text about daily step goals were helpful.</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>5. The pedometer was not a useful tool for tracking steps.</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>6. The daily step goals were helpful in increasing my physical activity.</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>7. The increasing step goals were too burdensome.</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>8. I am happy with the overall experience.</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

9. Was there any portion of the experience you would like to change? If so, what change(s) do you recommend? ____________________________________________________________________________
## APPENDIX F: PARTICIPANTS RATINGS OF QUESTIONS ON THE READINESS TO CHANGE QUESTIONNAIRE

Participants’ ratings of questions on the Readiness to Change Questionnaire.

<table>
<thead>
<tr>
<th>Item</th>
<th>P313</th>
<th>P314</th>
<th>P315</th>
<th>P316</th>
<th>P317</th>
<th>P318</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. As far as I’m concerned, my physical activity level is not a problem that needs changing.</td>
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<td>2. I think I might be ready to increase my physical activity.</td>
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30. I am actively working on my physical activity.  4  3  4  3  4  5

31. I would rather cope with my lack of physical activity than try to change it.  2  1  2  3  1  1

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<tr>
<td>1. How motivating was the lottery?</td>
<td>Not at all. I don't need the money. No need at all.</td>
<td></td>
<td></td>
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<tr>
<td>2. How important was earning lottery draws to you?</td>
<td>Not really.</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>3. Did you like the lottery? Why or why not?</td>
<td>Neither liked or disliked. Just wasn't motivating.</td>
<td></td>
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</tr>
<tr>
<td>4. Did you like the goals? Why or why not?</td>
<td>I appreciated the goals, even though I didn’t them meet very often. It's important to say I did try. I did do extra walks with Marcy (the dog). I wouldn’t have without the goals.</td>
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</tr>
<tr>
<td>5. Did you like the videos? Why or why not?</td>
<td>They were fun, because we like you.</td>
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<td></td>
</tr>
<tr>
<td>6. When you met a goal did it encourage you to work harder on the next day?</td>
<td>No, but it made me happy.</td>
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</tr>
<tr>
<td>7. When you earned money back, how important was that to you?</td>
<td>Not really. Take it or leave it.</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>8. When you earned money back, did it increase or decrease your motivation to take more steps the next day?</td>
<td>Neither.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. If you met a goal, but didn’t win money, were you discouraged or were you motivated to meet your goal?</td>
<td>Meeting the goal was encouraging enough.</td>
<td></td>
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</table>
10. Did you think the $42 deposit was too little or too much, and why? $2 wasn’t motivating. Maybe I would have liked knowing the highest value ticket. I struggle with mental health which made it hard to get motivated.

11. What would be your maximum deposit amount? $200

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</thead>
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<tr>
<td>1. How motivating was the lottery?</td>
<td>On a scale from 1-10, maybe a 6-7. I wanted to recover my money, but I would have liked more of an interesting game. $2 wasn’t motivating enough given the stresses of life.</td>
</tr>
<tr>
<td>2. How important was earning lottery draws to you?</td>
<td>On a scale from 1-10, a 5 or 6</td>
</tr>
<tr>
<td>3. Did you like the lottery? Why or why not?</td>
<td>Medium liked, wanted more diverse lottery, maybe. Only 2 options, there was only $2 or praise. This got redundant.</td>
</tr>
<tr>
<td>4. Did you like the goals? Why or why not?</td>
<td>Yes. A good reminder to prepare for the day.</td>
</tr>
<tr>
<td>5. Did you like the videos? Why or why not?</td>
<td>Good to reminder that I was in the program.</td>
</tr>
<tr>
<td>6. When you met a goal did it encourage you to work harder on the next day?</td>
<td>Yes, I would say yes, even though I didn’t do it often, it was rewarding to see. Definitely felt good. When I was tired after work, thinking about the $2 wasn’t motivating enough compared to life and rewards from relaxing.</td>
</tr>
<tr>
<td>7. When you earned money back, how important was that to you?</td>
<td>When thinking about the $2 a day, it wasn’t that big of a deal to lose the money.</td>
</tr>
</tbody>
</table>
8. When you earned money back, did it increase or decrease your motivation to take more steps the next day?

It challenged me to want to do it, but throughout the day the motivation changed. If I did put the Fitbit on, it probably meant I was interested.

9. If you met a goal, but didn’t win money, were you discouraged or were you motivated to meet your goal?

Disappointing, but I turned it into a challenge. I continued to wear the Fitbit. Because maybe this could get me to where I want to be.

10. Did you think the $42 deposit was too little or too much, and why?

Maybe $100 would be more motivating. Instead of thinking of that negative, I would work making the prizes more interesting. I was under the impression we would earn prizes.

$100

11. What would be your maximum deposit amount?

$100

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Item | P315's Responses
--- | ---
1. How motivating was the lottery? | It was motivating after I drew the $10 ticket.
2. How important was earning lottery draws to you? | Very.
3. Did you like the lottery? Why or why not? | I didn’t like it because when I met my goal I wouldn’t get the reinforcement. Had I known about a $75, the 10 wouldn’t have been as reinforcing. When I got a lot of $2’s that made the $10 more reinforcing.
4. Did you like the goals? Why or why not? | I did.
5. Did you like the videos? Why or why not? | They were funny. There was a lot of whispering. Maybe be a bit louder.
6. When you met a goal did it encourage you to work harder on the next day? No, not really.

7. When you earned money back, how important was that to you? Important.

8. When you earned money back, did it increase or decrease your motivation to take more steps the next day? Yes.

9. If you met a goal, but didn’t win money, were you discouraged or were you motivated to meet your goal? Discouraged.

10. Did you think the $42 deposit was too little or too much, and why? It was a reasonable amount.

11. What would be your maximum deposit amount? Top would be $100.

<table>
<thead>
<tr>
<th>Item</th>
<th>P316's Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>How motivating was the lottery?</td>
</tr>
<tr>
<td>2.</td>
<td>How important was earning lottery draws to you?</td>
</tr>
<tr>
<td>3.</td>
<td>Did you like the lottery? Why or why not?</td>
</tr>
<tr>
<td>Item</td>
<td>Item P317's Responses</td>
</tr>
<tr>
<td>------</td>
<td>----------------------</td>
</tr>
<tr>
<td>1. How motivating was the lottery?</td>
<td>I wasn’t doing it for the money. I was trying to meet the goals. I was wondering what the big ticket was.</td>
</tr>
<tr>
<td>4. Did you like the goals? Why or why not?</td>
<td>It made me think more how much I wasn’t walking. When my steps got higher it wasn’t that hard to get higher steps.</td>
</tr>
<tr>
<td>5. Did you like the videos? Why or why not?</td>
<td>Yea, because I could see it wasn’t rigged.</td>
</tr>
<tr>
<td>6. When you met a goal did it encourage you to work harder on the next day?</td>
<td>Yes.</td>
</tr>
<tr>
<td>7. When you earned money back, how important was that to you?</td>
<td>It was important, but towards the end, once I got closer to my deposit it became a little less motivating.</td>
</tr>
<tr>
<td>8. When you earned money back, did it increase or decrease your motivation to take more steps the next day?</td>
<td>Increased, but also I knew it was going to be a bit harder to meet my next goal.</td>
</tr>
<tr>
<td>9. If you met a goal, but didn’t win money, were you discouraged or were you motivated to meet your goal?</td>
<td>Motivated more, especially because it was my money.</td>
</tr>
<tr>
<td>10. Did you think the $42 deposit was too little or too much, and why?</td>
<td>It was just right.</td>
</tr>
<tr>
<td>11. What would be your maximum deposit amount?</td>
<td>$50</td>
</tr>
</tbody>
</table>
2. How important was earning lottery draws to you?  | Not very important.
3. Did you like the lottery? Why or why not?  | It was interesting what I drew.
4. Did you like the goals? Why or why not?  | Yes, I liked the challenge. However, some days were very difficult to be motivated because I was sad that my daughter left for college.
5. Did you like the videos? Why or why not?  | The goals were informative. Let you know if you met it or not. Instead of a voicemail or something a human helped. It was professional.
6. When you met a goal did it encourage you to work harder on the next day?  | Yes.
7. When you earned money back, how important was that to you?  | It was ok.
8. When you earned money back, did it increase or decrease your motivation to take more steps the next day?  | Increased.
9. If you met a goal, but didn’t win money, were you discouraged or were you motivated to meet your goal?  | Didn’t discourage. I’m was going to try again the next day even if I didn’t get anything.
10. Did you think the $42 deposit was too little or too much, and why?  | It's fine. Not too much, not too little.
11. What would be your maximum deposit amount?  | (see previous)
<table>
<thead>
<tr>
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<th>P318's Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. How motivating was the lottery?</td>
<td>Very motivating, getting a goal and being accountable for it.</td>
</tr>
<tr>
<td>2. How important was earning lottery draws to you?</td>
<td>Earning money was more important than just the praise.</td>
</tr>
<tr>
<td>3. Did you like the lottery? Why or why not?</td>
<td>Yes, thought it was a good system. The action of you picking and the video. Showed you were looking at the goals and willing to reward me.</td>
</tr>
<tr>
<td>4. Did you like the goals? Why or why not?</td>
<td>Yea. I think the morning was better. It was a good reminder and motivated me to start stepping as soon as possible. Goals got really hard at the end. They were doable it just got hard in the end. I just needed extra effort to do it. Sufficient.</td>
</tr>
<tr>
<td>5. Did you like the videos? Why or why not?</td>
<td>Yes, it did.</td>
</tr>
<tr>
<td>6. When you met a goal did it encourage you to work harder on the next day?</td>
<td>Moderately important, it meant when something when I did, but when I didn’t it didn’t discourage.</td>
</tr>
<tr>
<td>7. When you earned money back, how important was that to you?</td>
<td>I don’t think it increased my motivation to take steps, it increased my motivation to meet my goal the next day.</td>
</tr>
<tr>
<td>8. When you earned money back, did it increase or decrease your motivation to take more steps the next day?</td>
<td>No.</td>
</tr>
<tr>
<td>9. If you met a goal, but didn’t win money, were you discouraged or were you motivated to meet your goal?</td>
<td>No.</td>
</tr>
</tbody>
</table>
10. Did you think the $42 deposit was too little or too much, and why? Just right, if it was $50 it would have been too much.

11. What would be your maximum deposit amount? (see previous)