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Evaluation of the Dogs, Physical Activity, and Walking (Dogs PAW) Intervention: A Randomized Controlled Trial

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Evaluation of the Dogs, Physical Activity, and Walking (Dogs PAW) Intervention: A Randomized Controlled Trial

Abstract: Background. To facilitate physical activity (PA) adoption and maintenance, promotion of innovative population-level strategies that focus on incorporating moderate intensity, lifestyle PA are needed. **Objectives.** The purpose of this randomized controlled trial was to evaluate the Dogs, Physical Activity, and Walking intervention (PAW), a 3-month, social cognitive theory (SCT) e-mail based PA intervention. Methods. In a longitudinal, repeated measures design, 49 dog owners were randomly assigned to a control (n=25) or intervention group (n=24). The intervention group received email messages (twice-weekly for four weeks and weekly for eight weeks) designed to influence SCT constructs of self-efficacy, self-regulation, outcome expectations and expectancies, and social support. At baseline and every 3 months through 1 year, participants completed self-reported questionnaires of individual, interpersonal, and PA variables. Linear mixed models were used to assess for significant differences in weekly minutes of dog walking and theoretical constructs between groups (intervention and control), across time. To test self-efficacy as a mediator of social support for dog walking, tests for mediation were conducted using the bootstrapping technique. Results. With the exception of month 9, participants in the intervention group accumulated significantly more weekly minutes of dog walking than the control group. On average, the intervention group accumulated 58.4±18.1 more minutes of weekly dog walking than the control group ($p<0.05$). Self-efficacy partially mediated the effect of social support variables on dog walking. Discussion. Results indicate that a simple theory based-email intervention is effective in increasing and maintaining an increase in dog walking among dog owners at 12-month follow-up. In light of these findings, it may advantageous to design dog walking interventions that focus on increasing self-efficacy for dog walking by fostering social support.

Keywords: social cognitive theory, mediation, physical activity, intervention, pets

Despite the well-known health benefits of an active lifestyle, most U.S. adults fail to meet physical activity (PA) recommendations which recommend adults achieve 150 minutes of moderate PA each week (Centers for Disease Control and Prevention, 2012a). While many PA interventions have shown small to moderate effects, maintenance of PA behavior change post-

intervention remains elusive (Fjeldsoe, Neuhaus, Winkler, & Eakin, 2011). To facilitate PA adoption and maintenance of an active lifestyle, promotion of innovative population-level strategies that focus on incorporating moderate intensity, lifestyle PA are needed. A large segment of the population that these PA promotion strategies could target is dog owners. It is estimated that close to 50% of U.S. households own a dog (The United States Humane Society, 2013) and up to 70% of dog owners do not walk their dog enough to achieve the health benefits of an active lifestyle (i.e., decreased the risk of coronary heart disease, hypertension, type 2 diabetes, osteoporosis, depression, obesity, breast and colon cancers) (Christian et al., 2013; Reeves, Rafferty, Miller, & Lyon-Callo, 2011). Promotion of dog walking fits well within the *One Health* strategy, an international strategy focusing on expanding interdisciplinary collaborations in all aspects of health care for humans, animals and the environment by recognizing that human health is connected to animal health (King et al., 2008). Dog walking can be described as a multi-purpose activity because it benefits both the health of the owner and the dog and is associated with social cohesiveness by brining neighbors together and facilitating social interactions (Toohey & Rock, 2011). Therefore, this segment of the population may be suitable to target PA interventions.

Physical Activity and Dog Walking

Dog walking can be described as any type of walking in which the dog owner and dog are walking together. The dog may be on or off leash. While the intensity of dog walking may vary based on owner and dog characteristics, when dog walking was objectively assessed with accelerometers, 82% of all dog walking minutes were classified as at least moderate intensity which occurred in bouts of 10 minutes or more (Richards, Troped, & Lim, 2014). This is an important finding as it is inline with activity that is considered health-enhancing based on the U.S. Physical Activity Guidelines (Physical Activity Guidelines Advisory Committee, 2008).

Cross-sectional studies suggest that dog walking is positively associated with meeting PA guidelines (Christian et al., 2013; Hoerster et al., 2011; Lentino, Visek, McDonnell, & DiPietro, 2012; Reeves et al., 2011; Richards, McDonough, Edwards, Lyle, & Troped, 2013) however, studies also suggest that many dog owners do not walk their dog(s) at a level sufficient to achieve health benefits for themselves or their dog(s) (Bauman, Russell, Furber, & Dobson, 2001; Reeves et al., 2011).

Besides the current study, six dog walking intervention studies have been published to date (Byers et al., 2014; Johnson & Meadows, 2010; Kushner, Blatner, Jewell, & Rudloff, 2006; Morrison et al., 2013; Rhodes, Murray, Temple, Tuokko, & Higgins, 2012; Schneider et al., 2015). Four of these interventions were randomized controlled trials (RCT) (Byers et al., 2014; Morrison et al., 2013; Rhodes et al., 2012; Schneider et al., 2015) and only one was based on a health behavior theory; specifically social cognitive theory (SCT) (Morrison et al., 2013). Only three of the interventions had any type of follow-up post-intervention and this follow-up was limited to 3 months or less (Byers et al., 2014; Morrison et al., 2013; Rhodes et al., 2012). None of these interventions reported significant increases in PA compared to control groups. Therefore, dog walking intervention research could benefit from following participants beyond three months and incorporating health behavior theory.

Theoretical Framework

PA is a complex health behavior and no single determinant can predict or explain PA adoption and maintenance. Therefore, PA determinants need to be viewed in the context of several individual, interpersonal, and environmental characteristics. SCT encompasses this view of health behavior through the principle of reciprocal determinism (Bandura, 1997). In SCT, reciprocal determinism describes the dynamic interactions between the person, their health behavior, and the social and physical environment. The central SCT construct, self-efficacy, refers to an individual's confidence in the ability to perform a behavior, overcome barriers to that behavior, and exert control over the behavior through self-regulation and goal setting (Bandura, 1997). In SCT, the environment is broadly defined to include social environmental factors such as social support. Outcome expectations are the consequences an individual anticipates from taking behavioral action and outcome expectancies are the value an individual places on those particular outcomes (Bandura, 1997). It is believed that self-efficacy has a direct influence on PA and also acts as a mediator of other SCT constructs such as social support (Maddux, 1995). Self-efficacy is also thought to influence outcome expectations and expectancies, which then directly influence health behavior (Bandura, 1997; Maddux, 1995).

In addition, pet ownership and specifically pet attachment, has been shown to be strongly related to health outcomes such as a greater likelihood of surviving a heart attack, lower blood pressure, triglyceride, and cholesterol levels, and better emotional and psychological health (Garrity, Stallones, Marx, & Johnson, 1989; Raina, Waltner-Toews, Bonnett, Woodward, &

Abernathy, 1999; Stallones, Marx, Garrity, & Johnson, 1990). In fact, it has been hypothesized that pet provided social support may be a resource that directly enhances health and also buffers the impact of stress (Garrity et al., 1989). For example, in a nationwide sample of older adults, strong pet attachment was associated with less depression among those recently experience a death in the family (Garrity et al., 1989). Furthermore, in a sample of dog owners, pet attachment was associated with owner weight status and owner perceptions of human social support (Stephens et al., 2012).

To date, few PA intervention studies have examined the mediating framework between theoretical constructs and PA behavior change (Rhodes & Pfaeffli, 2010). Specifically, in a review of mediators of PA behavior change, only three studies attempted to examine SCT constructs but none tested for a conceptual theory link. Therefore, the evidence of SCT constructs and intervention-based PA behavior change is limited (Rhodes & Pfaeffli, 2010). Mediation analysis is critical to understanding why or why not the intervention was effective.

Purpose

The purpose of this study was to conduct a longer-term evaluation of the ability of the Dogs, Physical Activity, and Walking (PAW) intervention to increase dog walking among dog owners. We have previously reported on the feasibility, acceptability, and immediate outcomes of the Dogs PAW post-intervention (Richards, Ogata, & Ting, 2014). In this previous study, participants agreed that the intervention e-mails were easy to read and understand and that the frequency of e-mails was adequate. Immediately post intervention, the intervention group significantly increased weekly minutes of dog walking. However, to assess maintenance of this behavior change, longer-term follow-up was needed. The current paper expands on intervention results one year after the intervention. In addition, a secondary purpose of the current study is to examine whether changes in behavioral theoretical constructs mediated changes in dog walking behavior. It was hypothesized that participants randomly assigned to the intervention group would show a significant increase in their dog walking when compared with participants in the control group and that these changes would remain one year after the start of the intervention. In addition, it was hypothesized that self-efficacy variables would be a significant mediator of social support variables and dog walking behavior.

Methods

Design and participants

A two-group, RCT design was used. Power analysis calculation indicated that 19 dog owners were needed in each group (intervention and control) for a total sample size of 38 (power = 0.80, when alpha=0.05). To account for potential study dropout, our goal was to recruit at least 21 dog owners per group for a total sample size of 42.

In the spring of 2013, dog owners were recruited through flyers and email messages targeted at pet stores, veterinary offices, and large places of employment. In addition, an advertisement was placed in the local newspaper. Inclusion criteria were dog owners 18 years of age and older who reported little (<20 minutes a week) or no dog walking in a typical week. Participants also needed to report regular use of email. Exclusion criteria included known cardiac or pulmonary disease, joint instability, pregnancy, and known thyroid disease. Seventy-nine participants expressed interest in the study. A research assistant screened participants for eligibility and then obtained informed consent on 49 participants (*see figure 1*). Participants were then randomly assigned to the intervention or control group by the lead researcher using a random number generator. The lead researcher was not blinded to group assignment. However, the research assistant who collected baseline data and measures was blinded to group assignment. As an incentive, all participants, regardless of group assignment, received a health screening at the beginning and at the end of the study (month 12). The health screening was conducted by a registered nurse (RN) and included a lifestyle questionnaire, height, weight, blood pressure, pulse, total cholesterol, high-density lipoprotein, and blood glucose. This RN had no knowledge of who was in the intervention or control group. Procedures were approved by the Purdue University Committee on the Use of Human Research Subjects.

Intervention Procedure and Structure

Dogs PAW is a three-month email-based RCT designed to increase dog walking among dog owners. A complete description of the intervention is published elsewhere (Richards, Ogata, & Ting, 2014). Briefly, Dogs PAW was developed to be in-line with SCT and based off the individual, interpersonal, and environmental correlates of dog walking found in two previous studies (Rhodes et al., 2012; Richards et al., 2013b).

Starting in June 2013, the intervention group received twice-weekly email messages for four weeks and weekly emails for eight weeks. Participants in the control group received one baseline email reviewing current PA guidelines. The intervention emails were designed to influence SCT constructs of self-efficacy, self-regulation, outcome expectations and

expectancies, and social support. Specifically, messages attempted to foster self-efficacy through the processes hypothesized in SCT (Bandura, 1997). For example, messages discussed the role of the dog as a motivator and social support mechanism for walking. In addition, participants were encouraged to walk the dog with friends and family as a way of increasing social support for walking and ultimately increasing self-efficacy. Furthermore, messages attempted to help participants gain a sense of control over their behavior by providing directions on goal setting and goal monitoring. Because studies have shown that outcomes for the dog are an important predictor in dog walking behavior, messages also educated dog owners not only about the health benefits for themselves but also about the specific health benefits for their dog (Richards et al., 2013b). In addition, to get at the sense of obligation to the dog, information was provided about the frequency and duration of dog walking certain dog breeds need (Rhodes et al., 2012).

Measures

Measurement of variables occurred at baseline, immediately post-intervention (3 months), and at 6, 9, and 12 months through standardized online questionnaires. Measurements were analogous for both the intervention and control group.

Sociodemographic characteristics. Age, gender, marital status, household income, education level, and employment status were assessed at baseline with a sociodemographic questionnaire designed for this study.

Health measures. At baseline and 12 months, total cholesterol, HDL, and blood glucose were tested using a Cholestech LDX machine. Blood was obtained from a finger stick. Number of poor physical health days and poor mental health days in the past 30 days was asked at each measurement point using the questions from the Behavioral Risk Factor Surveillance System (Centers for Disease Control and Prevention, 2012a). Body mass index (BMI) was calculated based on objectively measured height and weight using the following formula: weight (lb) / [height (in)]^2 x 703 (Centers for Disease Control and Prevention, 2015). Participants were classified as overweight if BMI was 25.0-29.9 and obese if BMI was ≥30.0 (Centers for Disease Control and Prevention, 2012b).

Theoretical constructs. Participants completed the Dogs and Walking Survey (DAWGS) tool at all measurement points. The DAWGS is a psychometrically sound instrument that examines individual and interpersonal correlates of dog walking. The development and

psychometric testing of the DAWGS has been previously reported (Richards, McDonough, Edwards, Lyle, & Troped, 2013a). The DAWGS includes items to assess self-efficacy for dog walking, outcome expectations and outcome expectancies of dog walking, and social support for dog walking from friends, family, and the dog(s). In addition to DAWGS items, pet attachment was assessed using the previously validated Lexington Attachment to Pets Scale (Johnson, Garrity, & Stallones, 1992). Pet attachment was assessed at baseline and month 12.

The self-efficacy for dog walking measure consisted of two factors of Likert-scale items: making time (5 items) (e.g., walked the dog even in the dark; get up early to walk the dog) and resisting relapse (4 items) (e.g., walk the dog when you have social obligations; walk the dog when family is asking for more time from you). Outcome expectation items were used to assess the benefits participants believe they derive from walking their dog(s). Outcome expectancy items were used to assess the value placed on each specific outcome. The outcome expectation and expectancy measures each consisted of two factors: owner-specific outcomes (5 Likert-scale items) (e.g., improve health, improve mood, companionship) and dog-specific outcomes (2 Likert-scale items) (e.g., improve dog behavior and have a happy dog). The social support for dog walking items measured social interactions and activities aimed at supporting dog walking behavior that the individual perceived to be receiving from their dog(s), family, and friends. This measure consisted of Likert-scale items and comprised three factors: dog social support (3 items) (e.g., having my dog makes me walk more; my dog provides support for me to go on walks), family social support (4 items) (e.g., family change their schedule to walk the dog with me; family plan activities with me that include dog walking) and friend social support (4 items) (e.g., friends walk the dog with me; friends encourage me to walk). The pet attachment measure consisted of three factors: general attachment (11 Likert-scale items) (e.g., I often talk to others about my pet, owning a pet adds to my happiness), people substituting (7 Likert-scale items) (e.g. I believe my pet is my best friend, quite often I confide in my pet), and animal rights and welfare (5 Likert-scale items) (e.g., pets deserve as much respect as humans do, I would do almost anything to take care of my pet) (Johnson et al., 1992).

Dog walking and physical activity. Dog walking, defined as an activity in which both the dog and the owner are walking together with the dog on or off leash, was assessed with three items: number of days of dog walking in a typical week, average number of dog walks per day, and the typical duration per dog walk. Weekly minutes of dog walking was calculated based on

the self-reported frequency and duration of dog walks. In addition, self-reported PA during the past seven days was assessed with six items from the International Physical Activity Questionnaire (Craig et al., 2003). Questions assessed the number of days and minutes per day of moderate and vigorous PA and walking performed for at least 10 minutes at a time.

Statistical Analysis

Descriptive statistics were used to summarize participant characteristics, theoretical constructs, and PA variables. Weighted means and standard deviations were calculated for continuous variables and frequencies and percentages for categorical variables. Chi-square and two-sample t-tests were used to assess differences between the intervention and control group at baseline and between baseline and post-intervention. Data were analyzed using R 3.2.2 (R Core Team, 2015). Statistical significance was set at $p < 0.05$ for measurement times baseline through 6 months, p-values <0.10 are also reported due to reduced sample size in the intervention group for measurement time periods of 9 and 12 months. These findings will require further investigation, however; the risk of rejecting important research hypotheses was judged more important that the risk of Type I error. Probability values greater than 0.05 but less than 0.10 are reported here as trends. Model diagnostics was performed to examine normality, constant variance and independence assumptions of each fitted model.

To examine if theoretical constructs changed across time, between groups, a linear mixed model, in which the group, time point, and their interaction were the independent variables, and participant ID was a random effect with no nesting structure was used. The across time points analyses were carried out by using Tukey's HSD test from the linear mixed modeling. To examine if changes in theoretical constructs resulted in changes in dog walking between groups, the across time points analyses were investigated by using a linear mixed model with group, time point, change of theoretical construct, and their interactions. This modeling strategy allows us to study how the changes of theoretical constructs influence the change of dog walking in different groups across time. Due to multicollinearity between theoretical constructs it was not appropriate to include all theoretical constructs in one model for a multivariate analysis, therefore; three linear fixed-effect models were used for the pet attachment constructs (since the changes from baseline were only available at the 12^{th} month and thus not longitudinal) and 9 linear mixed models were used for all other theoretical constructs.

To test self-efficacy (making time and resisting relapse) as a mediator of social support (dog,

family, friend) on dog walking, tests for mediation were conducted using the product of coefficients approach suggested by MacKinnon (2002) which included bootstrapping as discussed by Preacher & Hayes (2008). This approach is favored over the causal steps approach (Baron & Kenny, 1986) because the product of coefficients approach has been shown to have substantially more power and more accurate Type I error rates (MacKinnon, Lockwood, Hoffman, West, & Sheets, 2002). The significance of mediation pathway was evaluated using bootstrapping as this method provides the most power in obtaining confidence intervals (CIs) for indirect effects in small sample size (Preacher & Hayes, 2008). Specifically, 95%, bias-corrected (BC) and bias-corrected accelerated (BCa) CIs were calculated to determine if each proposed meditating variables (making time and resisting relapse) helped explain the relationship between social support and dog walking. Standard bootstrap percentile estimates are sometime inaccurate, especially with small-samples. Efron (1987) proposed bias-corrected (BC) and BC accelerated (BCa) methods using second-order correction to improve standard bootstrap CIs. Please see Preacher and Hayes (2008) for more discussion of the empirical evaluation of the BC(a) CIs. The 95% CIs of the indirect effects were obtained with 10,000 bootstrap resamples. A significant indirect effect via mediators between dependent and independent variables was determined if the 95% CIs did not contain zero (Preacher & Hayes, 2008). These models accounted for changes in variables across time.

Results

Sociodemographic Characteristics

Despite randomization, there was a significant age difference between the intervention and control group at baseline. Other than age, there were no other significant differences between the intervention and control group in demographics. In general, participants were middle-aged (mean=45.7±13.4 years), female (79.6%), and all were Caucasian. Participants were well-educated with a majority of participants completing at least a 2-year college degree. A complete description of participant characteristics has been previously reported (Richards, Ogata, et al., 2014).

Weekly Minutes of Dog Walking

At baseline, participants in both the intervention and control group reported less than 10 minutes per week of dog walking (*see Table 1*). With the exception of month 9 (data not shown), participants in the intervention group accumulated significantly more weekly minutes of

dog walking than the control group. Immediately post-intervention, the intervention group reported an average of 79.3±53.6 weekly minutes of dog walking compared to 19.4±23.9 weekly minutes in the control group ($p<0.10$). At 6 months, the intervention group reported 57.4±55.5 weekly minutes compared to 27.1±43.5 in the control group ($p<0.05$). At 9 months, the intervention group decreased weekly minutes of dog walking (33.3±45.9; p=NS) while the control group remained stable (26.7±87.8 minutes; data not shown). At twelve months the control group average 18.6±21.4 weekly minutes of dog walking while the intervention group averaged 80.0±34.4 weekly minutes of dog walking ($p<0.05$). Moreover, significant across time, between-group differences in dog walking was shown by linear mixed model. On average, the intervention group accumulated 58.4±18.1 more minutes of weekly dog walking than the control group ($p<0.05$).

Theoretical Constructs

At baseline, there were no significant differences in theoretical constructs between groups (*see Table 1*). There were no significant changes in theoretical constructs at month three in the control group. The intervention group reported a significant increase in dog-related social support for walking (Control group: 6.0±2.1 vs. 7.0±2.4; Intervention group: 6.5±2.2 vs. 8.4±3.0; $p<0.05$). There were no significant changes in theoretical constructs at month six in either the control group or intervention group. At 12-month follow-up, the only significant between-group difference in theoretical constructs was found in the friend-related support for dog walking. Compared to the control group, the intervention group reported a significant increase in family related social support for dog walking (Control group: 3.9±1.6 vs. Intervention group: 5.6±3.8; $p<0.10$).

Health Status

At baseline, there were no significant differences between groups. On average, participants were considered obese with an average BMI of 29.7±5.7 in the control group and 30.3±5.3 in the intervention group. In general, although not statistically significant, the intervention group tended to report a greater number of poor physical or mental health days over the past month. At the one-year follow-up, there were no significant differences between groups.

Overall Physical Activity

At baseline, there were no significant differences in weekly minutes of walking, moderate intensity PA (MPA) or vigorous intensity PA (VPA) between groups (*see Table 1*). In the control

group, PA levels remained relatively unchanged across month 3 and 6 and increased at month 12, although not significantly. In the intervention group, PA levels remained relatively unchanged across month 3 and 6. When compared to previous time points and to the control group, the intervention group significant increased minutes of VPA at month 12 (Control group: 104.3±156.0 vs. 131.2±237.5; $p<0.05$).

Changes in Theoretical Constructs and Dog Walking

When examining the relationship between changes in theoretical constructs with changes in dog walking minutes, no significant findings emerged at month 3 (*see Table 2*). At month 6, there were no significant relationships between theoretical constructs and dog walking found in the control group. In the intervention group, owner-specific outcome expectations was significantly associated with increased dog walking minutes ($\beta=16.9\pm9.8$; $p<0.10$). No significant associations were found between theoretical constructs and dog walking at month 9 in either group. At 12-month follow-up, 'general pet attachment' was negatively associated with dog walking in the control group ($\beta=-4.2\pm1.4$; $p<0.05$) and demonstrated a positive trend in the intervention group ($\beta=26.3\pm13.2$; $p<0.10$). In addition, family-related social support demonstrated a positive trend in the intervention group ($\beta=21.3\pm13.0$; $p<0.10$).

Mediation

The product of coefficients approach, using bootstrapping, provided the test of whether the change in self-efficacy (making time and resisting relapse) significantly mediated the relationship between social support (dog, family, friend) and weekly minutes of dog walking (*see Table 3*). The making time subscale of self-efficacy significantly mediated the associations between social support and weekly minutes of dog walking [dog support (95% BCa CI: [1.59, 4.35]); family support (95% BCa CI: [0.62, 2.38]); friend support (95% BCa CI: [0.73, 4.34])]. The resisting relapse subscale of self-efficacy significantly mediated the associations between dog support (95% BCa CI: [0.74, 3.52]) and friend support (95% BCa CI: [0.59, 4.13]) but not family support (95% BCa CI: [-0.14, 2.09]).

Discussion

Results of this intervention indicate that a simple theory based-email intervention is effective at increasing and maintaining an increase in dog walking among dog owners at 12-month follow-up. It is important to note that the decline in dog walking seen in month 9 is likely impacted by seasonality. This measurement period occurred in February when the weather was

very cold and snowy in the Midwest. Previous studies have shown leisure time PA to be impacted by cold or rainy weather (Matthews et al., 2001). However, other studies have shown that dog walking is not strongly impacted by inclement weather (Temple, Rhodes, & Higgins, 2011).

Results of this intervention are consistent with SCT and pet attachment theory (Bandura, 1997; Johnson et al., 1992). Immediately post-intervention, increases in social support were seen in the intervention group. Also in-line with SCT, outcome expectations were associated with dog walking at month 6. According to SCT, social support influences self-efficacy and then increases in self-efficacy should influence outcome beliefs. The current study's mediation analysis extends previous research by highlighting the importance of social support specifically for enhancing dog walking self-efficacy. These findings indicate that a supportive social environment is positively related to both self-efficacy and dog walking behaviors and generally aligns well with The Guide to Community Preventive Services (Kahn et al., 2002) recommendations for social support interventions to increase PA. Dogs specifically can provide social support by being a companion for PA. The increase in pet attachment at month 12 in the intervention group suggests dog walking might have fostered an increase in feelings of pet attachment.

Importantly, the increase seen in dog walking in the intervention group does not appear to be at the sacrifice of other forms of PA. For example, weekly minutes of walking and MPA remained stable in the intervention group and weekly minutes of VPA significantly increased from baseline to 12 months.

A major strength of this study was the use of a health behavior theory, SCT, in the development of this intervention. To the authors' knowledge, this is the first theory-based dog walking intervention to be developed and tested. However, this study did have a relatively small sample and therefore replication is warranted in a larger trial with more diverse populations. In addition, this study relied on self-report for dog walking and overall PA which is prone to recall and social desirability bias. However, the survey items measuring dog walking and the theoretical constructs have previously been tested and were shown to be reliable and valid measures. In addition, attrition was higher in the intervention group. However, most of the attrition occurred for unavoidable issues outside of the intervention (i.e. dog death, relocated, participant illness).

Overall, the generalizability of this study is high. Given that the intervention was delivered via email, the setting for the intervention is easily transferable and implementation costs are low. In addition, the mediation outcomes support that the intervention was effective in changing the theoretical constructs it sought out to influence.

Conclusions

The results of this study support that this intervention is effective in increasing dog walking among dog owners. Increasing self-efficacy for dog walking by fostering social support and providing education on the benefits of dog walking for both the owner and the dog can promote increases in dog walking which can ultimately result in increased overall PA.

The role of social support from the dog also supports the idea that motivation in the form of obligation to someone or something else may be a catalyst for PA. A sense of this obligation could be fostered by providing information on the expected outcomes or benefits of PA for this other person or dog (Rhodes et al., 2012). By further exploring and attempting to influence the factors that motivate dog owners to walk their dog, this knowledge could be used to help understand and increase walking behaviors in general.

Using a dog walking strategy for PA promotion has the potential to facilitate long-term behavior change as people who own dogs typically sustain dog ownership for many years. This strategy also has the potential for wide public health reach since 47% of U.S. households own at least one dog with a majority not being regularly walked (The United States Humane Society, 2013). For dog owners who are inactive, promotion of dog walking may be a good strategy to increase PA. Dogs can provide motivation for owners' walking by the dog's expectations to be walked and by providing social support and a sense of safety as an exercise companion.

References

Bandura, A. (1997). *Self-efficacy: The exercise of self control*. New York, NY: W.H. Freeman and Company.

Baron, R. M., & Kenny, D. A. (1986). The moderator-mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations. *Journal of Personality & Social Psychology, 51*(6), 1173-1182.

Bauman, A. E., Russell, S. J., Furber, S. E., & Dobson, A. J. (2001). The epidemiology of dog walking: an unmet need for human and canine health. *Medical Journal of Australia, 175*(11-12), 632-634.

Byers, C. G., Wilson, C. C., Stephens, M. B., Goodie, J. L., Netting, F. E., & Olsen, C. H. (2014). Owners and pets exercising together: Canine response to veterinarian-prescribed physical activity. *Anthrozoos, 27*(3), 325-333.

Centers for Disease Control and Prevention. (2012a). Behavioral Risk Factor Surveillance System Survey Data. Atlanta, GA.

Centers for Disease Control and Prevention. (2012b). Defining overweight and obesity. Retrieved February 24, 2015, 2015, from http://www.cdc.gov/obesity/adult/defining.html

Centers for Disease Control and Prevention. (2015). BMI Calculation and Interpretation. from http://www.cdc.gov/healthyweight/assessing/bmi/adult_bmi/index.html#Interpreted

Christian, H., Wesgarth, C., Bauman, A., Richards, E. A., Rhodes, R., Volpe, S., & Thorpe, R. (2013). Dog ownership and physical activity: A review of the evidence. *Journal of Physical Activity and Health, 10*(5), 750-759.

Craig, C. L., Marshall, A. L., Sjöström, M., Bauman, A. E., Booth, M. L., Ainsworth, B. E., . . . Oja, P. (2003). International physical activity questionnaire: 12-country reliability and validity. *Medicine & Science in Sports & Exercise, 35*(8), 1381-1395. doi: 10.1249/01.MSS.0000078924.61453.FB

Efron, B. (1987). Better bootstrap confidence intervals. *Journal of the American statistical Association, 82*(397), 171-185.

Fjeldsoe, B., Neuhaus, M., Winkler, E., & Eakin, E. (2011). Systematic review of maintenance of behavior change following physical activity and dietary interventions. *Health Psychology, 30*(1), 99-109. doi: 10.1037/a0021974

Garrity, T. F., Stallones, L., Marx, M. B., & Johnson, T. P. (1989). Pet ownership and attachment as supportive factors in the health of the elderly. *Anthrozoos, 3*(1), 35-44.

Hoerster, K. D., Mayer, J. A., Sallis, J. F., Pizzi, N., Talley, S., Pichon, L. C., & Butler, D. A. (2011). Dog walking: its association with physical activity guideline adherence and its correlates. *Preventive Medicine, 52*(1), 33-38. doi: 10.1016/j.ypmed.2010.10.011

Johnson, R. A., & Meadows, R. L. (2010). Dog-walking: motivation for adherence to a walking program. *Clinical Nursing Research, 19*(4), 387-402. doi: 10.1177/1054773810373122

Johnson, T. P., Garrity, T. F., & Stallones, L. (1992). Psychometric evaluation of the Lexington Attachment to Pets Scale. *Anthrozoos, 5*, 160-175.

Kahn, E. B., Ramsey, L. T., Brownson, R. C., Heath, G. W., Howze, E. H., Powell, K. E., . . . Corso, P. (2002). The effectiveness of interventions to increase physical activity. A systematic review. *American Journal of Preventive Medicine, 22*(4 Suppl), 73-107.

King, L. J., Anderson, L. R., Blackmore, C. G., Blackwell, M. J., Lautner, E. A., Marcus, L. C., . . . Mahr, R. K. (2008). Executive summary of the AVMA One Health Initiative Task Force report. *Journal of the American Veterinary Medical Associaiton, 233*(2), 259-261. doi: 10.2460/javma.233.2.259

Kushner, R. F., Blatner, D. J., Jewell, D. E., & Rudloff, K. (2006). The PPET Study: people and pets exercising together. *Obesity, 14*(10), 1762-1770. doi: 10.1038/oby.2006.203

Lentino, C., Visek, A. J., McDonnell, K., & DiPietro, L. (2012). Dog walking is associated with a favorable risk profile independent of moderate to high volume of physical activity. *Journal of Physical Activity & Health, 9*(3), 414-420.

MacKinnon, D. P., Lockwood, C. M., Hoffman, J. M., West, S. G., & Sheets, V. (2002). A comparison of methods to test mediation and other intervening variable effects. *Psychological Methods, 7*(1), 83-104.

Maddux, J. (1995). *Self-efficacy, adaptation, and adjustment: Theory, research, and application*. New York, NY: Plenum Press.

Matthews, C. E., Freedson, P. S., Hebert, J. R., Stanek, E. J., Merriam, P. A., Rosal, M. C., . . . Ockene, I. S. (2001). Seasonal variation in household, occupational, and leisure time physical activity: longitudinal analyses from the seasonal variation of blood cholesterol study. *American Journal of Epidemiology, 153*(2), 172-183.

Morrison, R., Reilly, J. J., Penpraze, V., Westgarth, C., Ward, D. S., Mutrie, N., . . . Yam, P. S. (2013). Children, parents and pets exercising together (CPET): exploratory randomised controlled trial. *BMC Public Health, 13*, 1096. doi: 10.1186/1471-2458-13-1096

Physical Activity Guidelines Advisory Committee. (2008). *Physical activity guidelines advisory committee report*. Washington D.C.: Retrieved from http://www.health.gov/PAGuidelines/Report.

Preacher, K. J., & Hayes, A. F. (2008). Asymptotic and resampling strategies for assessing and comparing indirect effects in multiple mediator models. *Behavioral Research Methods, 40*(3), 879-891.

R Core Team. (2015). R: A language and environment for statistical computing. R Foundation for Statistical Computing. Retrieved February 24, 2015, from https://www.R-project.org/

Raina, P., Waltner-Toews, D., Bonnett, B., Woodward, C., & Abernathy, T. (1999). Influence of companion animals on the physical and psychological health of older people: an analysis of a one-year longitudinal study. *Journal of the American Geriatrics Society, 47*(3), 323-329.

Reeves, M. J., Rafferty, A. P., Miller, C. E., & Lyon-Callo, S. K. (2011). The impact of dog walking on leisure-time physical activity: results from a population-based survey of Michigan adults. *Journal of Physical Activity & Health, 8*(3), 436-444.

Rhodes, R. E., Murray, H., Temple, V. A., Tuokko, H., & Higgins, J. W. (2012). Pilot study of a dog walking randomized intervention: effects of a focus on canine exercise. *Preventive Medicine, 54*(5), 309-312. doi: 10.1016/j.ypmed.2012.02.014

Rhodes, R. E., & Pfaeffli, L. A. (2010). Mediators of physical activity behaviour change among adult non-clinical populations: a review update. *International Journal of Behavioral Nutrition and Physical Activity, 7*, 37. doi: 10.1186/1479-5868-7-37

Richards, E., McDonough, M., Edwards, N., Lyle, R., & Troped, P. (2013a). Development and psychometric testing of the Dogs and WalkinG Survey (DAWGS). *Research Quarterly for Exercise & Sport, 84*(4), 492-502. doi: 10.1080/02701367.2013.839935

Richards, E., McDonough, M., Edwards, N., Lyle, R., & Troped, P. (2013b). Psychosocial and environmental factors associated with dog walking. *International Journal of Health Promotion and Education, 51*(4), 198-211. doi:10.1080/14635240.2013.802546

Richards, E., Ogata, N., & Ting, J. (2014). Dogs, Physical Activity, and Walking (Dogs PAW): Acceptability and Feasibility of a Pilot Physical Activity Intervention. *Health Promotion, 16*(3), 362-370. doi: 10.1177/1524839914553300

Richards, E., Troped, P., & Lim, E. (2014). Assessing the intensity of dog walking and impact on overall physical activity: A pilot study using accelerometry. *Open Journal of Preventive Medicine, 4*(7), 523-528. doi**:** 10.4236/ojpm.2014.47062

Schneider, K. L., Murphy, D., Ferrara, C., Oleski, J., Panza, E., Savage, C., . . . Lemon, S. C. (2015). An online social network to increase walking in dog owners: a randomized trial. *Medicine & Science in Sports & Exercise, 47*(3), 631-639. doi: 10.1249/MSS.0000000000000441

Stallones, L., Marx, M. B., Garrity, T. F., & Johnson, T. P. (1990). Pet ownership and attachment in relation to the health of U.S. adults, 21 to 64 years of age. *Anthrozoos, 4*(2), 100-112.

Stephens, M. B., Wilson, C. C., Goodie, J. L., Netting, F. E., Olsen, C. H., & Byers, C. G. (2012). Health perceptions and levels of attachment: owners and pets exercising together. *The Journal of the American Board of Family Medicine, 25*(6), 923-926. doi: 10.3122/jabfm.2012.06.110325

Temple, V., Rhodes, R., & Higgins, J. (2011). Unleashing physical activity: An observational study of park use, dog walking, and physical activity. *Journal of Physical Activity and Health, 8*, 766-774.

The United States Humane Society. (2013). Pets by the numbers. from http://www.humanesociety.org/issues/pet_overpopulation/facts/pet_ownership_statistics.html

Toohey, A. M., & Rock, M. J. (2011). Unleashing their potential: a critical realist scoping review of the influence of dogs on physical activity for dog-owners and non-owners. *International Journal of Behavioral Nutrition and Physical Activity, 8*, 46. doi: 10.1186/1479-5868-8-46

Table 1. Mean (SD) of measures stratified by group at baseline, 3, 6, and 12 months

	Control								Intervention							
	Baseline (n=25)		3 Months (n=25)		6 Months (n=24)		12 months (n=23)		Baseline (n=24)		3 months (n=24)		6 Months (n=23)		12 months (n=17)	
Weekly minutes of dog walking	7.2	(8.8)	19.4	(23.9)	27.1	(43.5)	18.6	(21.4)	9.0	(9.4)	79.3	(53.6) ‡‡**	57.4	(55.5) ¥¥	80.0	(3.5)¥¥**
Pet Attachment																
General attachment	10.4	(2.8)	NM		NM		10.6	(3.1)	11.1	(3.5)	NM		NM		11.4	(3.5)
People substituting	10.6	(1.5)	NM		NM		10.6	(1.6)	11.1	(1.9)	NM		NM		11.9	(1.6)
Animal rights/welfare	18	(2.2)	NM		NM		17.5	(2.5)	18.3	(2.8)	NM		NM		18.6	(2.9)
Self-efficacy																
Resisting relapse	10.7	(3.5)	9.8	(2.8)	9.6	(3.1)	10	(2.8)	11	(2.7)	11.2	(3.5)	10.9	(3.5)	10.6	(4.2)
Making time	10.2	(2.8)	9.1	(2.6)	9.3	(2.6)	9.1	(2.3)	10.3	(1.7)	9.9	(3.0)	9.4	(3.0)	9.8	(3.8)
Outcome Expectations																
Owner-specific	11.8	(2.1)	12	(1.7)	12	(1.7)	11.8	(1.8)	12.8	(1.7)	11.4	(3.5)	12.9	(1.8)	12.6	(3.5)
Dog-specific	8.8	(0.8)	8.3	(1.1)	8.4	(1.3)	8.8	(0.9)	9.0	(1.1)	8.0	(2.6)	9.1	(1.0)	9.0	(2.1)
Outcome Values																
Owner-specific	13.8	(2.2)	13.8	(1.9)	13.6	(1.8)	13.3	(1.4)	14.7	(3.2)	13.4	(3.7)	14.6	(2.3)	14.2	(3.8)
Dog-specific	10.2	(1.1)	10.2	(1.2)	9.8	(1.1)	10.0	(1.2)	10.2	(1.9)	9.6	(2.6)	9.7	(1.4)	9.9	(2.4)
Social Support																
Dog-support	6	(2.1)	7	(2.4)	6.5	(2.0)	6.8	(2.5)	6.5	(2.2)	8.4	(3.0) ‡‡	7.7	(3.1)	7.8	(3.4)
Friend-support	3.8	(1.4)	3.7	(1.2)	3.8	(1.5)	3.9	(1.6)	4.6	(1.7)	5.2	(2.8)	4.5	(2.1)	5.6	3.8*
Family-support	5.2	(2.3)	5.2	(2.5)	5.6	(2.8)	5.4	(2.5)	5.6	(2.6)	6.6	(3.2)	6.3	(3.1)	6.7	(3.5)
Health Status																
BMI	29.7	(5.7)	NM		NM		29.2	(4.7)	30.3	(5.3)	NM		NM		28.7	(4.8)
Total cholesterol	190.5	(54.9)	NM		NM		181	(40.5)	195.5	(40.5)	NM		NM		187.8	(37.6)
Blood sugar	91.6	(11.7)	NM		NM		94.7	(19.4)	98.9	(36.5)	NM		NM		96.4	(33.1)
HDL	54.6	(18.5)	NM		NM		65.7	(15.4)	53.6	(14.8)	NM		NM		62.6	(19.7)
Poor physical health days	1.2	(2.2)	1.7	(2.5)	2.1	(3.2)	2.5	(4.8)	3.6	(6.5)	4.1	(4.9)	5.4	(9.0)	5.5	(10.1)
Poor mental health days	3.8	(5.9)	5.8	(7.9)	3.2	(5.4)	3.5	(5.4)	4.9	(6.7)	3.1	(4.8)	5.3	(6.7)	3	(5.3)
Weekly minutes of PA																
Vigorous PA	67.4	(67.0)	66	(68.2)	64	(82.8)	104.3	(156.0)	47.5	(82.5)	60.4	(112.0)	50.4	(78.1)	131.2	(237.5) ‡‡¥

Moderate PA	73.6	(70.2)	79.8	(84.7)	109.7	(120.8)	159.3	(230.8)	56	(120.9)	105.6	(181.8)	33.7	(34.0)	101.6	(131.4)
Walking	76.4	(72.8)	129.5	(165.1)	111.9	(126.5)	111.7	(102.2)	95.2	(73.4)	128.1	(118.4)	104.4	(77.8)	128.9	(128.6)

HDL= high-density lipoprotein; NM= not measured; PA= physical activity

Significance mark of difference between groups across time:

Difference from Control Group: * p<0.10; ** p<0.05

Difference from previous time: ‡ p<0.10; ‡‡ p<0.05

Difference from baseline: ¥ p<0.10; ¥¥p<0.05

Table 2. Associations β (SD) between change in theoretical construct and change in dog walking from baseline, stratified by group.

	Baseline to 3rd month				Baseline to 6th month				Baseline to 9th month				Baseline to 12th month			
	Control (n=24)		Intervention (n=23)		Control (n=24)		Intervention (n=23)		Control (n=23)		Intervention (n=15)		Control (n=22)		Intervention (n=16)	
Pet Attachment																
General attachment	Not measured		Not measured		Not measured		Not measured		Not measured		Not measured		-4.2	(1.4) **	26.3	(13.2) *
People substituting	Not measured		Not measured		Not measured		Not measured		Not measured		Not measured		-0.6	(2.9)	-0.1	(22.8)
Animal rights/welfare	Not measured		Not measured		Not measured		Not measured		Not measured		Not measured		-0.4	(2.3)	28.2	(23.3)
Self-efficacy																
Resisting Relapse	0.2	(4.8)	6.0	(5.9)	0.0	(6.3)	-1.9	(8.1)	8.6	(6.0)	-12.4	(8.0)	1.0	(6.7)	7.2	(8.2)
Making Time	-0.9	(7.1)	5.6	(8.9)	0.6	(8.7)	-4.6	(11.5)	4.2	(8.6)	-10.8	(11.1)	2.7	(8.8)	3.3	(11.2)
Outcome Expectations																
Owner-specific	1.5	(6.5)	1.9	(7.0)	-0.1	(7.7)	16.9	(9.8) *	-4.9	(9.4)	8.6	(10.3)	-0.2	(8.0)	7.4	(9.0)
Dog-specific	-3	(11.8)	2.3	(12.4)	6.4	(13.9)	-2	(16.4)	-2.8	(15.9)	-1.7	(17.3)	5.2	(18.4)	-9.2	(19.3)
Outcome Values																
Owner-specific	0.3	(4.1)	1.8	(4.5)	1.8	(5.7)	4.5	(6.5)	1.2	(6.4)	-1.0	(8.9)	-2.4	(7.1)	9.2	(7.8)
Dog-specific	-1.1	(7.6)	3.0	(8.2)	7.1	(12.3)	-1.2	(13.1)	-0.8	(11.2)	-7.9	(14.2)	-2.8	(14.2)	6.0	(15.0)
Social Support																
Dog-support	-0.1	(6.3)	4.3	(7.5)	2.7	(8.3)	-4.7	(10.3)	11.4	(8.2)	-15.8	(10.3)	-3.6	(8.2)	16.4	(10.8)
Friend-support	-5.4	(8.7)	5.1	(10.5)	-8.9	(11.9)	-11.3	(15.3)	-0.7	(11.7)	-18.6	(15.2)	-9.2	(12.7)	-9.3	(14.6)
Family-support	2.1	(6.0)	8	(8.2)	-0.6	(6.7)	4.9	(12.4)	1.2	(7.5)	-5.1	(11.8)	-0.1	(9.9)	21.3	(13.0) *

Significance mark of difference between baseline and post-intervention: * p<0.10; ** p<0.05

Table 3. Mediation test results and 95% bootstrapped (from 10,000 resampling replicates) confidence intervals of the mediation effect

		Product of coefficients:	Bootstrapping 95% CIs		
Mediator	IV	Mediation effect	Percentile	BC	BCa
Making time	Dog support	2.70	[1.48, 4.17]	[1.61, 4.39]	[1.59, 4.35]
	Family support	1.36	[0.53, 2.25]	[0.63, 2.39]	[0.62, 2.38]
	Friend support	2.21	[0.49, 4.03]	[0.78, 4.49]	[0.73, 4.34]
Relapse	Dog support	1.87	[0.69, 3.42]	[0.85, 3.80]	[0.74, 3.52]
	Family support	0.77	[-0.21, 1.95]	[-0.10, 2.17]	[-0.14, 2.09]
	Friend support	1.95	[0.34, 3.71]	[0.65, 4.27]	[0.59, 4.13]

CI = confidence interval

BC = bias-corrected

BCa = bias-corrected accelerated