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Pilot testing of a mindfulness- and acceptance-based intervention for increasing cardiorespiratory fitness in sedentary adults: A feasibility study

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Abstract

Objective—Vigorous physical activity (PA) has been promoted for improving cardiorespiratory fitness (CRF). However, therapeutic techniques designed to engage participants in vigorous PA have fallen short; one reason for this may be the unpleasant physical sensations associated with vigorous exercise (e.g., temporary shortness of breath and mild muscle soreness). Mindfulness and acceptance-based therapies such as Acceptance and Commitment Therapy (ACT) may be helpful at improving adherence to vigorous PA levels. In this open clinical trial, we sought to demonstrate the feasibility and acceptability of a mindfulness- and acceptance-based intervention for increasing CRF in sedentary adults and to generate initial outcomes data.

Design—Participants (N=24) engaged in a 10-week fitness walking program while attending regular group sessions based on ACT.

Main outcome measures and results—The feasibility and acceptability of the intervention were demonstrated through high levels of walking adherence (89.30%) and group session attendance (85.50%). A large significant decrease in total 1-mile walk test time [$t(18)=4.61$, $p=.0002$, $d=.64$] and a moderate significant increase in estimated VO_{2max} [$t(18)=-4.05$, $p=.0007$, $d=-.43$] were observed. Analyses indicated a large significant increase in exercise-related experiential acceptance [$t(18)=-9.19$, $p<.0001$, $d=-2.09$].

Conclusion—This study demonstrates the feasibility and acceptability of an ACT-based intervention for supporting participation in vigorous PA in sedentary individuals.

Keywords

Cardiorespiratory fitness; Mindfulness; Acceptance and commitment therapy; Physical activity; Sedentary

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1. Introduction

Increasing physical activity (PA) has long been supported as an important behavior change for health improvement. Vigorous PA, in particular, has been promoted for improving cardiorespiratory fitness (CRF), which has a strong inverse relationship with premature morbidity and mortality in adults (Lee et al., 2011; Williams & Thompson, 2013). Further epidemiological research has shown that vigorous PA has greater health benefits, in terms of blood pressure and glucose control, than moderate-intensity PA (Swain & Franklin, 2006). In addition, it has been found that vigorous PA produces greater cardioprotective benefits, including decreased risk for coronary heart disease, while lower intensity PA is associated with minimal risk reduction (Lee et al., 2011; Lee, Sesso, Oguma, & Paffenbarger, 2003; Sesso, Paffenbarger, & Lee, 2000; Tanasescu et al., 2002). However, the dose–response curve between CRF levels and risk reduction has not shown an evenly graded relationship. The largest risk reduction occurs in individuals moving from the lowest to the second-lowest fitness category, suggesting that public health efforts should focus on the most sedentary individuals (Blair et al., 1989; Blair, & Church, 2003; Kodama et al., 2009; Lee et al., 2011; Myers et al., 2002, 2004).

1.1. CRF and PA

Although the greatest health gains are made through vigorous PA, many fitness and PA trials prescribe moderate-intensity exercise programs, perhaps because they expect to observe difficulties in adherence to high-intensity regimens (Duncan et al., 2005; Swain & Franklin, 2006). The affective response to varying exercise intensity levels has been investigated to elucidate these differences in adherence rates. Ekkekakis (2003) purported, in his Dual Mode Model, that affective responses to exercise are impacted by both cognitive factors (e.g., self-efficacy) and interoceptive cues (e.g., muscular or respiratory). Furthermore, while intensity may not influence affective response from pre- to post-exercise, affective responses during exercise are likely to become more negative as the intensity increases, possibly impacting adherence (Ekkekakis, Hall, & Petruzello, 2008).

Cognitive-behavioral therapies (CBTs) widely used in fitness and PA trials (e.g., Duncan et al., 2005; Dunn et al., 1999) often seek to modify cognitions and affective responses to internal sensations during PA by controlling, restructuring, or eliminating negative thoughts, with the goal of promoting behavioral engagement. For example, restructuring a negative self-statement such as “I am a failure at exercising” into a positive self-statement like “I am proud of myself for trying to exercise” can impact an individual’s motivation as well as their self-efficacy to engage in PA behaviors. However, these trials have yielded only modest improvements of about 1/2 metabolic equivalent (MET)[3] or less (a disease risk reduction goal is 1–2 METs) (Blair et al., 1989; Lee et al., 2011) and highlight the difficulty of having individuals maintain even moderate-intensity PA (Church, Earnest, Skinner, & Blair, 2007; Duncan et al., 2005; Dunn et al., 1999).

3One MET is equivalent to a VO_2 of 3.5 ml/kg/min or the energy expenditure of sitting at rest.

1.2. Contextual CBTs

Acceptance and Commitment Therapy (ACT) (Hayes, Strosahl, & Wilson, 1999) is part of a larger class of therapeutic approaches known as "contextual CBTs" (Hayes, Luoma, Bond, Masuda, and Lillis, 2006; Hayes et al., 2011). This label is derived from their focus on the context or function of a problematic cognition or emotion rather than its content, form, or frequency. The overarching goal of ACT is to produce greater psychological flexibility, decreasing experiential avoidance of negative internal events (Hayes et al., 2006). Psychological flexibility can be thought of as the ability to accept the presence of unwanted sensations, thoughts, or feelings in the present moment and to act in a values-based fashion (Hayes, 2004; Lillis, Hayes, Bunting, & Masuda, 2009). Experiential avoidance, in the ACT paradigm, refers to the tendency of humans to avoid or escape negative internal experiences (Hayes, Stroshal, & Wilson, 1999; Hayes, 2004); attempts to fix, alter, or restructure these unwanted private experiences can distract individuals from a values-based behavioral path.

There are six core processes that facilitate psychological flexibility in the ACT model: values, committed action, acceptance, cognitive defusion, present-moment contact, and self-as-context. The process of acceptance is defined as a willingness to experience uncomfortable or even painful internal events (e.g., thoughts, feelings, sensations, and memories) without engaging in avoidance or change strategies for the sake of valued living (Hayes et al., 1999; Hayes, 2004). Cognitive defusion refers to the process through which one creates a distance or "space" between themselves and their thoughts, so that one may hold thoughts lightly and increase their behavioral repertoire (Hayes et al., 1999; Hayes, 2004). Self-as-context refers to "the self being a perspective from which thoughts, feelings, and experiences are observed, without judgment, as they pass through the context of the self (Hayes et al., 2006). The primary goal of ACT is to help an individual engage in mindful, values-based living. Values are persistent, may be enacted on an ongoing basis, and have a global quality, uniting various patterns of action (Hayes et al., 1999). Once values have been clarified, committed actions designed to achieve values-based goals are carried out as mindful, purposeful behaviors (Hayes et al., 1999; Hayes, 2004).

1.3. Contextual CBTs as applied to PA

A considerable amount of research exists regarding the efficacy of contextual CBTs in the area of mental health (Hayes, Villatte, Levin, & Hildebrandt, 2011; Ruiz, 2012), and empirical support is growing for their application to behavioral medicine, including issues such as chronic pain (McCracken, MacKichan, & Eccleston, 2007; Vowles & McCracken, 2008), type 2 diabetes management (Gregg, Callaghan, Hayes, & Glenn-Lawson, 2007), smoking cessation (Bricker, Wyszynski, Comstock, & Heffner, 2013; Gifford et al., 2004), epilepsy (Lundgren, Dahl, Melin, & Kies, 2006), obesity (Lillis et al., 2009), weight management (Forman, Butryn, Hoffman, & Herbert, 2009; Tapper et al., 2009), and PA (Butryn, Forman, Hoffman, Shaw, & Juarascio, 2011). These ACT-based promotions of health-related behavior change suggest that this mindfulness and acceptance-based approach may be uniquely suited for interventions in behavioral medicine (Gregg et al., 2007; Lillis et al., 2009; Tapper et al., 2009).

Promising findings from recent randomized controlled trials of ACT-based interventions for weight loss and PA-directed behaviors include a significant effect of a mindfulness-based weight loss intervention on PA (Tapper et al., 2009) and a significant impact of a brief ACT-based intervention on increasing gym visits among college students (Butryn et al., 2011). Recently, Moffitt and Mohr (2015) trial of a self-managed ACT-based intervention DVD for PA showed significant increases in post-intervention PA levels. However, one limitation of these trials was the use of self-reported measures for PA or proxy behaviors (e.g., entering the university gym), which are often inaccurate and do not allow for the interpretation of objective changes in participants' health status (Dhurandhar et al., 2014; Helmerhorst, Brage, Warren, Besson, & Ekelund, 2012; Prince et al., 2008; Sloane, Snyder, Demark-Wahnefried, Lobach, & Kraus, 2009). The use of objective measures for PA and disease risk is an important next step in moving physical health research forward (Dhurandhar et al., 2014).

1.4. Current study

One reason that other therapeutic techniques have fallen short in engaging participants in vigorous PA may be the unpleasant physical sensations associated with vigorous exercise (e.g., temporary shortness of breath and mild muscle soreness). Mindfulness and acceptance-based therapies such as ACT may be particularly helpful in this regard, as these techniques have proven effective in fostering psychological flexibility towards negative internal events and health-related behavior change (Ruiz, 2010).

In this open trial, we determined the feasibility and acceptability of a manualized group intervention to promote adherence to an assigned fitness walking intervention for CRF in sedentary individuals. While the use of psychotherapeutic approaches for PA is not new, previous studies have often used techniques of cognitive change and control. This study is novel in that it used mindfulness- and acceptance-based techniques to address the potentially aversive aspects of PA. The findings of this study will support the feasibility and acceptability of this type of therapeutic intervention for PA and provide initial data for future studies to build on regarding the efficacy of this approach.

2. Methods

2.1. Study design and participants

This study was approved by the institutional review board at the participating institution. Participants were recruited through local advertising (print and electronic) and completed a telephone screening for initial eligibility. Eligible participants were adults who were classified as sedentary, as defined by the American College of Sports Medicine (ACSM) (i.e., <30 min of moderate PA 5 days per week or <20 min of vigorous PA 3 days per week; American College of Sports Medicine (2013)), for the preceding year on the basis of self-report and a fitness assessment (the Rockport 1-mile walk test). To ensure participant safety, the exclusion criteria included (a) a body mass index (BMI) below 18.5 or above 39; (b) current smoker; (c) a diagnosis of a cardiovascular, pulmonary, or metabolic disease; and (d) a physical condition that restricted the individual's ability to engage in vigorous walking or a "high-risk" status, as defined by the ACSM guidelines (2013).

As shown in the Consort diagram (see Fig. 1), 129 individuals responded to the recruitment efforts. Thirty-eight of those individuals chose not to undergo telephone screening after receiving more information regarding the study, 46 underwent telephone screening, and 45 were placed on a waitlist after the recruitment capacity had been reached. After an initial telephone screening, 40 individuals were identified as eligible. These participants attended an in-person assessment, during which paper-and-pencil measures were administered and weight and height were measured. Thirty-eight individuals were deemed eligible on the basis of the in-person assessment and underwent a final fitness assessment (the Rockport 1-mile walk test, described below) to ensure that their fitness levels met the inclusion criteria. Twenty-eight individuals were eligible following the baseline fitness assessment and were randomly assigned to one of four group sessions times, all of which occurred on different weeknights and included five to eight participants. Twenty-four participants initiated the 10-week intervention program, and 19 completed it. The final completers sample had a mean age of 50.47 years; they were mostly female (79%) and white (90%). Their mean weight was 81.45 kg, with a mean BMI of 29.02. Additional data regarding participant demographics can be found in Table 1.

2.1.1. Group therapy intervention—The mindfulness- and acceptance-based group intervention included eight 90-min sessions over 10 weeks. Sessions were held at a community-based, university-affiliated mental health clinic. The intervention was delivered according to a manual developed by the first two authors and underwent expert review. This manual employed key concepts, metaphors, and exercises commonly used in ACT that had been adapted to promote the adoption, adherence, and maintenance of a fitness walking program (see Table 2). Specifically related to the core processes of ACT, participants in the current study were instructed on skills that could facilitate the acceptance of negative feelings about exercise as well as the unpleasant physical sensations experienced while performing PA. In addition, participants were given several strategies to assist them in defusing from judgments about the state of their health or their perceived ability to participate in PA. Present-moment contact was discussed as an alternative to the experiential avoidance often associated with PA among individuals with low fitness levels. Related to self-as-context, participants in the study were encouraged to practice mindful, ongoing awareness of transient internal experiences, especially physical discomfort or unpleasant thoughts, and to notice that they were able to observe these transient experiences from the perspective of the self without being defined by them. Values were discussed regularly in several sessions, including the values that led participants to join the group and to persist in participation. Participants were encouraged to consider whether fitness was a value in and of itself or in the service of another value (e.g., longevity for the sake of family). The relationship among goals, values, and committed actions was discussed; participants were encouraged to identify and perform committed actions in support of values in addition to walking for fitness.

2.1.2. Fitness walking program—All participants were provided specific guidelines for engaging in a walking program, which consisted solely of brisk, fitness-directed walking, outside of the group setting, during the participant's free time. This mode of exercise requires minimal skill, equipment, or physical fitness (American College of Sports

Medicine, 2013). Following the ACSM guidelines (2013), participants were instructed to engage in high-intensity interval walking at least 3 days a week, for a minimum total of 25 min/occasion. Specifically, participants were instructed to build up to their target heart rate (i.e., 70–85% of their maximal heart rate) and maintain this effort for brief periods of 3–4 min before decreasing the intensity and lowering their heart rate for a similar interval period. This form of high-intensity interval walking has been shown to be feasible in many populations, including sedentary adults (Lunt et al., 2014) and produces similar or superior outcomes (i.e., fitness, body composition, glycemic control, and cardiovascular health) to moderate-intensity continuous exercise (Guiraud et al., 2012; Karstoft et al., 2013; Kilpatrick, Jung, & Little, 2014; Morikawa et al., 2011; Nemoto, Gen-no, Masuki, Okazaki, & Nose, 2007). Participants were instructed in the use of electronic heart rate monitors to track heart rate and were given behavioral guidelines for increasing or decreasing their heart rate appropriately (e.g., walking faster or up a hill to increase their heart rate and decreasing walking speed and resistance to lower their heart rate). Weekly exertion and heart rate goals were provided to participants, who recorded their progress on walking logs that were submitted to the project director weekly. Specifically, weekly walking logs included daily recordings of the participants' total walk time in minutes, the maximal rating of perceived exertion, and the maximum heart rate monitored. These weekly goals were gradually increased throughout the duration of the intervention to build participant tolerance for this new behavior (i.e., vigorous PA).

2.2. Measures

2.2.1. Ratings of perceived exertion—Participants were asked to monitor their maximum rating of perceived exertion (RPE) during the walking program using the Borg Scale (Borg, 1970), which provides qualitative descriptors of perceived effort, along with paired numeric ratings. Walking program instructions included target peak exertion levels for each walk; during the first week, the target peak was 13 (somewhat hard) and increased weekly for 4 weeks, after which the target peak remained at 17 (very hard) for the second half of the intervention.

2.2.2. Heart rate—Participants used electronic heart rate monitors (Omron HR-100C) during their fitness walking to gauge whether or not they were reaching their target heart rate. Participants' initial maximal heart rates (HR_{max}) were estimated using a standard formula (220-age=HR_{max}; American College of Sports Medicine, 2013). Participants were asked to gradually increase their target heart rate, beginning at the pulse rate (or beats per minute) associated with 70% HR_{max} and moving up to 85% HR_{max} over the 10-week intervention. The data were collected via self-reported logs that participants completed weekly, not directly downloaded from the monitors themselves. Participants recorded observed heart rates from the Omron electronic heart rate monitors on paper and pencil logs provided by the study, and turned these in during group sessions.

2.2.3. CRF—CRF was measured both pre- and post-intervention using the Rockport 1-mile walk test (Kline et al., 1987), which measures the time it takes to walk 1 mile "at best effort," as well as the individual's heart rate during the walk. The CRF measures derived from the walk test included the walk test time (total minutes and seconds) and estimated

aerobic capacity (VO_{2max}), which was calculated using a previously validated sex-specific formula that is based on the participant's heart rate during the test and their weight, age, and walk test time.[4] The validity for this estimation formula was initially established with validation and cross-validation groups (Kline et al., 1987). The correlations between the estimated VO_{2max} and actual VO_{2max} (i.e., measured through direct gas exchange) were high for both groups (n = 174; r=.93 and n = 169; r=.92, respectively). In addition, this measure has been further validated by numerous researchers for a variety of samples, including young and older adults (Fenstermaker, Plowman, & Looney, 1992; Hageman, Walker, Pullen, & Pellerito, 2001; O'Hanley et al., 1987). This measure extends the results of previous research using self-reported PA data through its measurement of an objective indicator of health and fitness. In addition, it offers some benefits over the direct measurement of maximal oxygen uptake, which requires extensive and expensive laboratory staff and equipment. Given its validity as a measurement of estimated aerobic capacity and its cost effectiveness, the Rockport 1-mile walk test is a sensible choice, especially compared to objective measurements, for feasibility trials such as this. In the current study, the test was conducted in a standardized manner, and participants were outfitted with an Omron HR-100C electronic heart rate monitor during the walk test, which provided a measure of their heart rate.

2.2.4. Psychological flexibility—Two separate measures of psychological flexibility were used in the trial. The Acceptance and Action Questionnaire-II (AAQ-II; Bond et al., 2011) is a 7-item Likert scale measure of general psychological flexibility, with good structure (i.e., unidimensional), reliability (α =.84 [.78–.88]), and validity. Higher scores indicate lower levels of flexibility. Engagement in acceptance of exercise-related internal experiences was measured using the Physical Activity Acceptance Questionnaire (PAAQ; Butryn et al., 2014). The PAAQ (mean α =.79) includes ratings of 5 items on a 7-point Likert scale, with higher scores indicating greater acceptance of internal barriers for PA (Butryn et al., 2011; Forman et al., 2009; Goodwin, Forman, Herbert, Butryn, & Ledley, 2012).

2.2.5. Treatment acceptability—Treatment acceptability was evaluated after the intervention using the following two questions, each measured on a 5-point Likert-scale (1 = not at all, 3 = somewhat, 5 = very): "How helpful did you find the strategies (e.g., acceptance, values, and defusion) for responding to urges or desires pushing you to make unhealthy choices regarding your physical activity?" and "How satisfied were you with the approach we used to help you make changes in your physical activity level?" These items were based on those developed by Forman et al. (2009) and used by others (e.g., Goodwin et al., 2012) to evaluate acceptance-based behavioral medicine treatments. There are no psychometric data available for these items.

2.3. Statistical analyses

Standardized forms and procedures were used to collect data, which were double-entered into Microsoft Excel to ensure accuracy. The data were exported to PASW 18 (IBM Corp.,

4Estimated VO_{2max}=132.853 – (.1692 × body weight in kg)–(.3877 × age) + (6.315 for men)–(3.2649 × time in min) –(.1565 h).

2009) for analyses. Listwise deletion was used for the primary and secondary analyses. Missing data did not exceed 5.3% for any item. Paired sample *t*-tests were used to analyze the mean change (baseline to post-intervention) on measures of CRF and psychological flexibility.

Growth curve modeling was used to examine the change over time in the PAAQ. A plot of these data over time showed substantial nonlinearity. To account for this, we used a latent basis growth curve model to model change over time and 95% confidence intervals (CIs) for parameters were estimated via 2000 bootstrap samples. Growth curve analyses were conducted using Mplus v7.2 software (Muthén and Muthén, 2014), and Full Information Maximum Likelihood was used to handle missing data.

3. Results

Independent sample *t*-tests were used to assess the baseline differences between completers and non-completers (defined as participants who initiated treatment but did not complete the 10-week intervention) for the following variables: age, baseline walk time, weight (kg), estimated VO_{2max}, AAQ-II, PAAQ, ethnicity, income, education, sex, and marital status. No statistically significant differences were found for any of the analyses performed (all *p*s > .05).

The average walk adherence rate (calculated by dividing the number of walking sessions completed during the 10-week intervention by the number of prescribed sessions) was 89.30%. In addition, participants were found to have 92% compliance with weekly maximum heart rate goals and 80% adherence to RPE goals. The correlation between average weekly compliance for heart rate goals and PAAQ change was −.36 ($p = .133$). Bootstrapping this correlation with 10,000 bootstrap samples resulted in a significant correlation (95% CI [−.866, −.097]). The correlation between average weekly compliance for RPE and PAAQ change was −.39 ($p = .096$). Bootstrapping this correlation with 10,000 bootstrap samples resulted in a significant correlation (95% CI [− .750, − .061]). The average group session attendance rate was 85.50%. When questioned about the acceptability of the intervention in promoting adherence to the prescribed program, participants reported finding the strategies used in the treatment mostly helpful (M=3.84, SD=.68), and they reported feeling mostly satisfied (M=4.32, SD=.58).

The results of the analyses indicated a significant, large-sized (Cohen, 1988) decrease of 64.69 seconds in total walk test time [$p = .0002$, d=.64[5]] and a significant and medium-sized increase of 2.9 ml/kg/min in estimated VO_{2max} [p=.0007, d= −.43]. On average, participants increased their estimated VO_{2max} from 24.43 ml/ kg/min to 27.34 ml/kg/min. Analyses indicated a non-significant, medium-sized increase in general psychological flexibility (AAQ-II) [$p = .26$, d=.37] and a significant, large-sized increase in exercise-related psychological flexibility (PAAQ) [$p < .0001$, d= −2.09] (see Table 3).

5Effect sizes were calculated according to the method suggested by Dunlop et al. (1996).

Data from the 12 PAAQ assessments were plotted and showed substantial nonlinear change, with most of the change occurring during the first 3 weeks of the intervention (see Fig. 2). The results from the latent basis growth curve analysis showed significant mean change over time (mean slope factor=8.5, 95% CI [2.6, 13.8]); however, there was also significant variability in this change (variance of slope factor=34.5, 95% CI [6.5, 87.8]). There was a significant intercept mean (mean intercept factor=31.2, 95% CI [23.2, 36.5]). The model fit was less than adequate (*RMSEA*=.253, *CFI*=.780, *SRMR* = .324). The correlation between the change in PAAQ and the change in estimated VO_{2max} (as calculated by the baseline scores minus the post-intervention scores) was .26 (p = .27). Bootstrapping this correlation with 10,000 bootstrap samples resulted in a non-significant correlation 95% CI [−.017, .730].

4. Discussion

4.1. Study outcomes

In this study, we demonstrated the feasibility and acceptability of a mindfulness- and acceptance-based treatment through participant retention, attendance, and adherence. Attrition was 21.0%, very near the a priori estimated rate of 20% on the basis of the results of previous trials (e.g., Dunn et al., 1999), and no significant demographic differences were identified between completers and non-completers. The high rates of participant attendance and adherence to the walking program (i.e., walking sessions, maximum heart rate goals, and RPE goals) demonstrate the feasibility and acceptability of both the therapeutic intervention and the PA portion of the trial. Treatment acceptability was further supported by the high self-reported ratings of satisfaction with, and the perceived helpfulness of, the therapeutic intervention. This study joins a growing body of literature regarding the feasibility and acceptability of mindfulness and acceptance-based interventions, particularly in the area of health behavior change in at-risk populations (e.g., Goodwin et al., 2012; Forman et al., 2009).

The results of this study also provide initial findings to encourage further research. Completers showed a significant increase in CRF, as assessed by both walk test-derived outcomes (walk test time and estimated VO_{2max}). On average, participants increased their estimated VO_{2max}, demonstrating an almost full MET gain (>4/5ths of a MET). From a public health perspective, this gain approaches a clinically meaningful health benefit, as a 1 MET increase is associated with an 8–20% reduction in cardiovascular and all-cause mortality for men and women (Myers et al., 2002, 2004, 2015; Swain and Franklin, 2006). The results also demonstrated an increase in psychological flexibility related to PA, reflecting a decrease in the avoidance of exercise-related internal experiences. Changes in global psychological flexibility were in the expected direction but did not reach significance, perhaps because of the behavior-specific psychological flexibility targeted by the treatment.

Results from the growth curve modeling of the PAAQ suggest several interesting effects. First, the significant mean and variance of the slope factor suggest that changes in the experiential acceptance of PA occurred within- and between-persons, indicating that the PAAQ changed over time for individuals but that this change was different for different people. Second, the significant mean of the intercept factor suggests that where you start out

initially in terms of your PAAQ score predicts where you will end up in the future, indicating that those with higher mean PAAQ scores will have a higher PAAQ score at the end of the intervention. Fig. 2 shows that most of the change in the PAAQ occurred within the first or second week of the intervention. In addition, there was significant heterogeneity in the change over time for this variable. The mean value of the PAAQ at post-test was 40.1 (SD = 6.4), but the lowest score was 26 (over two standard deviations from the mean) and the highest was 52 (almost two standard deviations from the mean). Recent research suggests that PA interventions in particular produce heterogeneous outcomes, even under strict protocol conditions in which treatment fidelity is high (Winett et al., 2014). Understanding and predicting this heterogeneity could allow researchers to provide more effective interventions. One method of identifying and predicting this heterogeneity is through the use of growth mixture models (Ram and Grimm, 2007). This study lacked the sample size to conduct these analyses; however, when sufficiently powered, this method could allow researchers to identify subgroups of people (i.e., responders vs. non-responders) and use baseline characteristics to predict participants' subgroups. The heterogeneity in the PAAQ and the estimated VO_{2max} was also likely a factor for the non-significant correlation between the two variables. Future research with larger sample sizes may identify a significant correlation between these variables.

4.2. Strengths and limitations

This study had several strengths that are worth noting. First, this is the first study to investigate the feasibility of ACT to increase adherence to an interval walking program aimed at increasing CRF. Exercise science research has found that interval training is an effective and efficient form of PA that can have a significant impact on physiological health (Karstoft et al., 2013; Morikawa et al., 2011; Nemoto et al., 2007); however, despite evidence of the benefits of vigorous PA, the rates of adherence to this behavior are low. The use of both interval training and vigorous PA demonstrates that the intervention employed in the current study was grounded in the latest exercise science research (DeFina et al., 2015; Karstoft et al., 2014; Myers et al., 2015). In addition, the use of an objective measure for the primary outcome (i.e., CRF) as opposed to a self-reported measure is a substantial strength of this study that allows for a more reliable measure of actual health outcomes. Finally, the use of growth curve modeling of psychological flexibility allows for a better understanding of how this construct changes over time. The use of these more intensive longitudinal analytic approaches allows for a better understanding of the growth of psychological flexibility by participants throughout the intervention, as well as inter-individual variability in this change.

These strengths notwithstanding, there were several limitations worth noting that are generally inherent to small feasibility and acceptability studies of innovative therapy. Most notably, the lack of a control group limits the causal claims that can be made on the basis of the results of this open trial, as changes may be attributed to the passage of time or to non-specific therapeutic effects. In addition, this trial lacked a long-term follow-up. However, a randomized controlled trial with long-term follow-up assessment points would have been inappropriately matched to this stage of research development. This study's main goal was to establish the feasibility and acceptability of our intervention and to provide initial data on

which future studies can build to solidify efficacy, effectiveness, and eventual translation into practice.

Another critical limitation relates to the measure used for primary outcome variables: a field test was used to measure estimated VO_{2max} rather than a measure of direct gas exchange. While the validation studies for the Rockport 1-mile walk test show high correlations between the estimated and actual measures of VO_{2max}, direct gas exchange continues to be the gold standard for measuring CRF. Furthermore, the behavior-specific measure of psychological flexibility used (the PAAQ) has yet to be subjected to rigorous psychometric testing; the general measure, although it has strong psychometric properties, failed to achieve significance, perhaps indicating limited sensitivity to the behavior-specific avoidance targeted by the treatment.

While the sample was homogeneous (i.e., educated, middle-aged, white females), which limits the generalizability of our findings, it also provides valuable information regarding the demographic to which this type of intervention might appeal the most and therefore, is more likely to continue engagement. In addition, although the treatment manual was revised on the basis of a consensus between two ACT-trained therapists and input from expert reviewers, only one therapist was available for intervention administration; thus, therapist effects could not be assessed directly.

4.3. Future directions

This open trial demonstrated the initial feasibility and acceptability of the use of a contextual CBT approach to increasing fitness-directed walking in a sedentary adult sample. The results need to be replicated and extended in larger randomized control trials with diverse participants and state-of-the-art measures (i.e., accelerometers). Carroll and Nuro (2002), in their stage model for psychotherapy development, suggested that the purpose of the second stage of manual development includes trials to build further efficacy for treatment. During this phase, a clear differentiation of the treatment condition from the control or comparison condition is necessary to establish treatment efficacy. Trials that include commonly used therapy techniques for health behavior change as usual care conditions would help to further establish the efficacy of this new intervention. Following this efficacy phase, continued research with different samples (i.e., health disparity samples or those with high-risk disease profiles) would serve to increase the generalizability of the results.

Further studies are needed to understand the mechanisms of change in this intervention. In future studies, the use of individual measures of constructs used in the therapy protocol (i.e., mindfulness, acceptance, cognitive defusion, and values) could help to explicate the differential impact each construct has on the behavior change process. In addition, the manual was designed specifically in a modular format to allow for flexibility in the order in which the constructs are presented. Changing this order may elucidate the importance of the constructs at differing times in the behavior change process. Given that most of the change in the PAAQ occurred within the first one or two treatment sessions, future studies should examine the utility of brief ACT interventions and account for the nonlinear change in the PAAQ by using non-parametric tests or modeling the nonlinear change via latent basis models. In addition, future studies could use growth mixture modeling to identify subgroups

of individuals who show unique PAAQ trajectories and try to predict these subgroups to identify individuals who will be more responsive to an ACT intervention. Given the non-significant correlation between change scores for the PAAQ and the estimated VO_{2max}, future research that is focused on efficacy trials for this intervention should explore the relationships among these variables to determine whether greater acceptance of barriers to PA is a mediator of the relationship between the intervention and CRF.

Consistent with the results of previous trials (e.g., Butryn et al., 2011; Forman et al., 2009; Gregg et al., 2007), this study's findings support the feasibility and acceptance of mindfulness and acceptance-based contextual therapies in the field of behavioral medicine, particularly for health behavior change. In addition, the feasibility and acceptability of these therapies were demonstrated with a previously sedentary sample, supporting a focus on identified at-risk populations for whom experiential avoidance may be high, such as in cases of chronic pain or progressing disability (Gifford et al., 2004; Vowles and McCracken, 2008).

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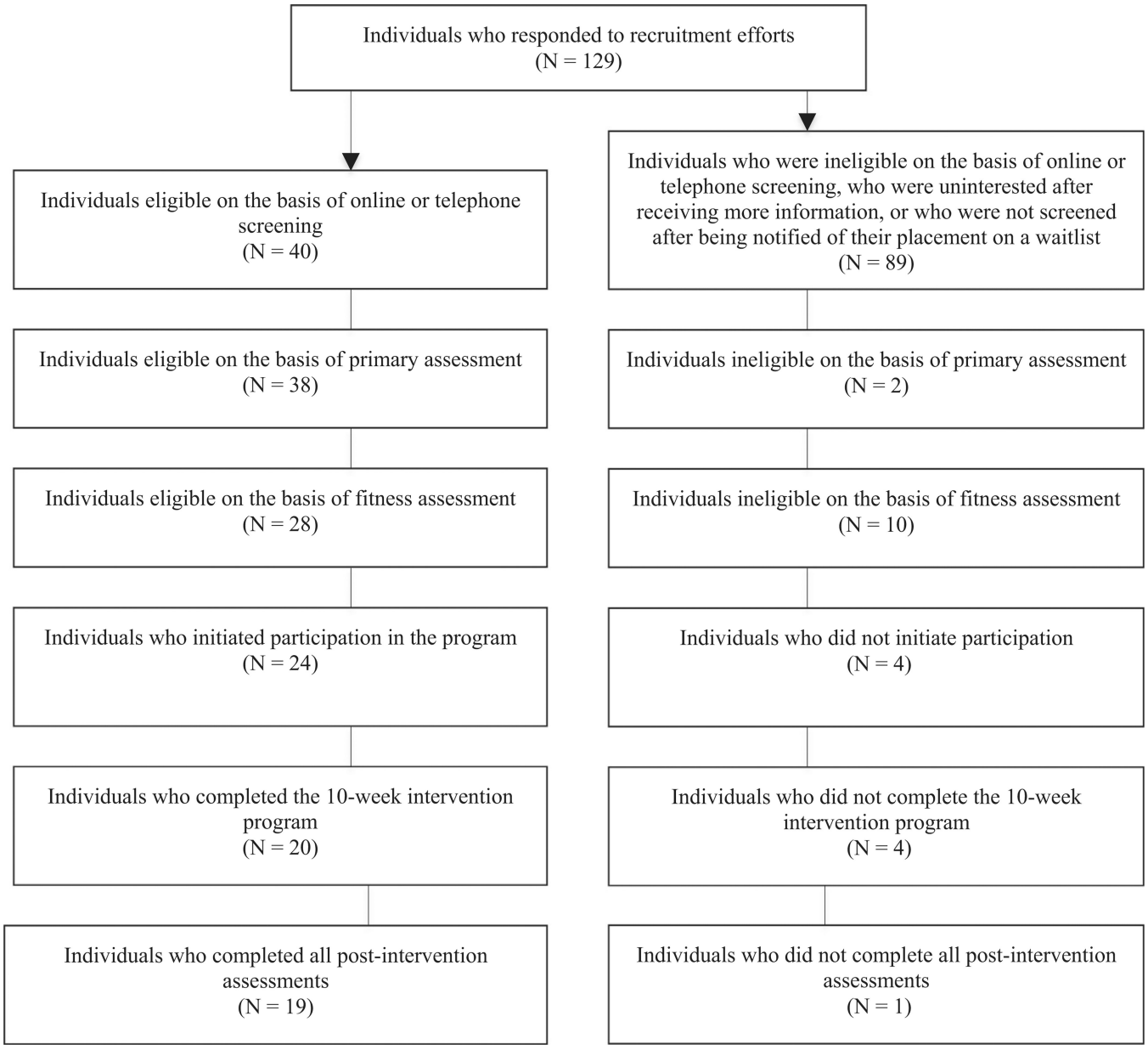

Fig. 1.
Consort diagram.

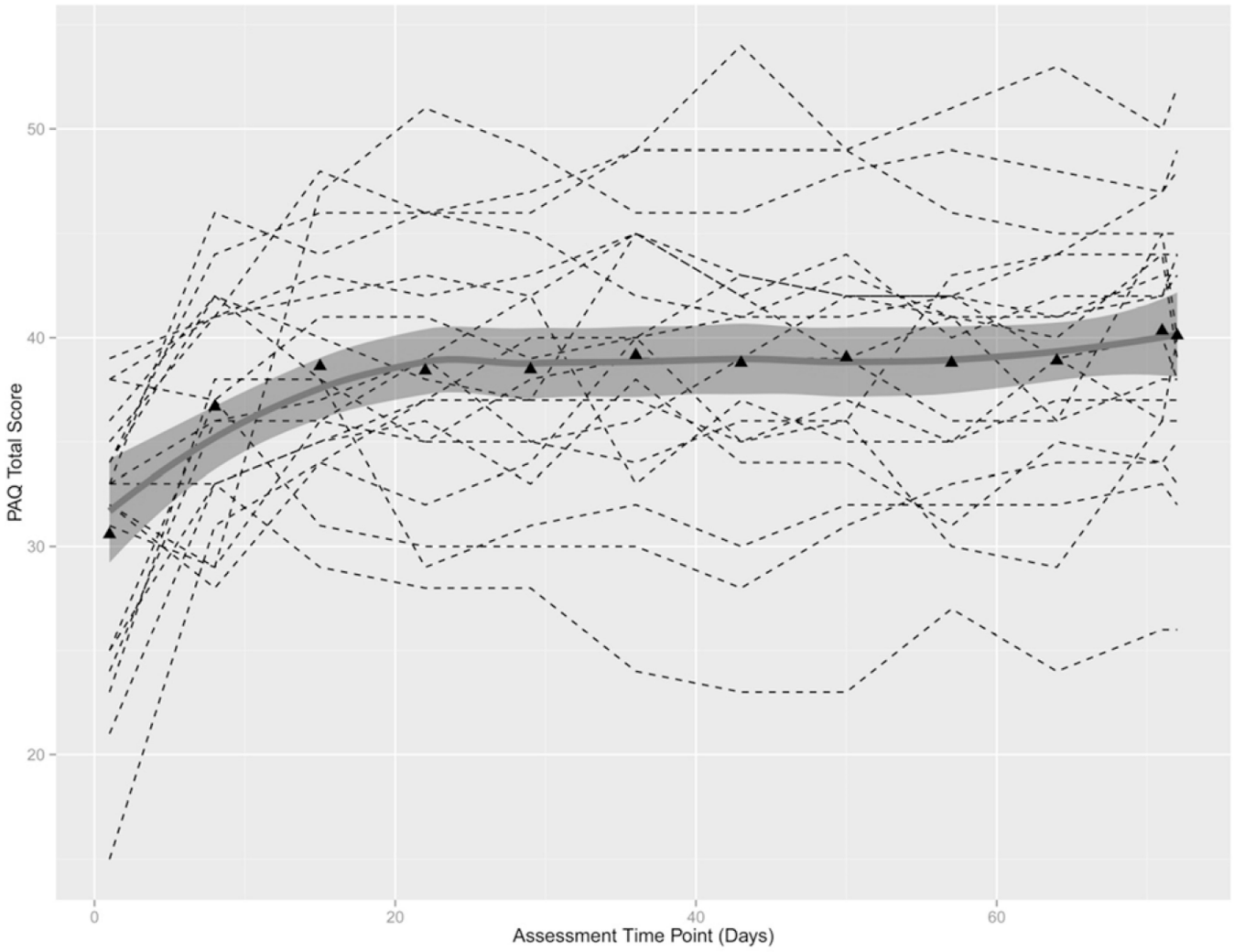

Figure 2.
PAAQ plotted over time, with means, lowess curve, and 95% confidence interval shading.

Table 1

Demographics of patients who completed the intervention.

Characteristic	Data (*N* = 19)
Age, years	50.47 (*SD* = 10.92)
Sex, *n*	
Female	15
Male	4
Weight (kg)	81.45 (*SD* = 19.14)
BMI (kg/m^2)	29.02 (*SD* = 4.28)
Marital status, *n*	
Married	17
Single	1
Divorced	1
Ethnicity, *n*	
Caucasian	17
Asian-American or Pacific Islander	1
Latino	1
Education, *n*	
High school	2
Some college	4
4-year college	6
Masters degree	6
Post-masters	1
Income ($), *n*	
10,001–20,000	1
20,001–30,000	0
30,001–40,000	0
40,001–50,000	1
50,001–60,000	2
60,001–70,000	1
70,001–80,000	2
80,001–90,000	10
N/A	2

Table 2

Manual protocol.

Session (week)	Topic or targeted component	Sample suggested exercises[a]	Aims or application to fitness intervention
1 (1)	Introduction	Magic wand activity	Familiarize participants with the concept of CRF and the fitness walking program protocol (i.e., RPE and heart rate monitor)
2 (2)	Values	The compass metaphor Skiing metaphor Values identification	Identify and clarify personal values Identify how increasing fitness supports such values Enhance motivation to increase fitness
3 (3)	Values, committed action, and barriers	Skiing metaphor	Identify goals consistent with the individual's values Help participants increase their awareness of and achieve fitness goals, despite internal and external barriers
		Two kids in the car metaphor	Encourage adherence to interval training and exercise strategies over the long term
		Demons on a boat metaphor	Bring awareness to day-to-day choices and the connection to one's goals
4 (4)	Mindfulness	Extended mindfulness practice: sweet spot exercise Sunset vs. math problem metaphor Monitoring of bodily reactions and feelings before, during, and after physical exercise to explore responses to acute bouts of activity	Enable negative internal events (i.e., thoughts) to flow without attachment Engaging in non-judgmental contact with psychological and physical events that occur Increase awareness during PA
5 (5)	Acceptance (willingness)	Backpack metaphor	Distress tolerance Acknowledgment vs. avoidance internal discomfort (i.e., negative emotions, cognitions, or bodily sensations)
		Path up the mountain metaphor Passengers on a bus metaphor	Recognize that modifying aversive or negative states often results in the delay or cessation of a goal-directed behavior
6 (6)	Acceptance through cognitive defusion	Leaves on a stream activity milk, milk, milk exercise Thought-distancing techniques – pushing against a clipboard exercise	Break the link between thoughts and behavior (fitness related) Be more aware of thoughts sabotaging exercise plans
7 (8)	Review	Review of selected exercises from above	Review key concepts Answer questions from participants
8 (10)	Maintenance	Identification of negative internal experiences related to lapses in fitness-directed activity	Continue to clarify values Renew commitment

[a]Complete list of suggested exercises available from the first author

Table 3

Baseline and post-intervention measures for primary and secondary outcomes.

Measure	Baseline		Post-intervention		Paired *t*-test (*df* = 18)		
	M	***SD***	***M***	***SD***	***T***	***p***	***d***
1-mile walk time (s)	980.95	99.34	916.26	102.54	4.61	<.01	.64
Estimated VO_{2max} (ml/kg/min)	24.43	6.71	27.34	6.83	− 4.05	<.01	− .43
AAQ II	17.84	7.45	10.53	27.25	1.18	.26	.37
PAAQ	3.14	.92	5.04	.90	−9.19	<.01	−2.09

Note: Higher scores on the AAQ-II indicate greater psychological inflexibility, while higher scores on the PAAQ indicate greater psychological flexibility. The table includes results for analyses conducted with the completer sample.