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Effect of a behavioral intervention on dimensions of self-regulation and physical activity among overweight and obese adults with type 2 diabetes: a pilot study

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ABSTRACT

The purpose of this pilot study was to determine the preliminary effect of a behavioral intervention on the use of self-regulation strategies and moderate-to-vigorous physical activity (MVPA) in overweight and obese adults with type 2 diabetes. 23 individuals recruited from ResearchMatc.org and campus advertisements were randomized into an intervention ($n = 12$) and control ($n = 11$) group. The intervention group received a behavioral intervention that used goal setting, time management, and self-monitoring to target dimensions of self-regulation and MVPA. The control received information regarding their PA habits. MVPA was measured via BodyMedia Armbands at pre- and post-test. The use of self-regulatory strategies for MVPA was assessed at pretest and posttest using the Self-Regulation for Exercise Scale. Cohen's *d* effect sizes were calculated to determine the practical impact of the intervention. The intervention had a large effect on all dimensions of self-regulation across time: including total self-regulation (3.15), self-monitoring (4.63), goal setting (3.17), social support (1.29), self-reward (1.98), time management (4.41), and overcoming barriers (2.25). The intervention had no impact on dimensions of MVPA across time. This pilot study demonstrated the ability of a behavioral intervention to improve the use of self-regulation strategies for MVPA in a sample of adults with type 2 diabetes. These findings can further inform the development of health promotion programs to promote self-regulation. Future research should focus on determining ability of improvements in self-regulation to stimulate behavior change.

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KEYWORDS
Physical activity; type 2 diabetes; self-regulation; behavior change

Introduction

Regular physical activity (PA) has lasting effects on type 2 diabetes (T2DM). Planned physical activity has consistently improved disease risk and outcomes (Espeland, 2007; Group LAR, 2010; Ratner, 2006). However, a majority of adults with T2DM are not engaging in regular PA (Nelson, Reiber, & Boyko, 2002). Diet and glucose management training has

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examined self-regulation as an important strategy for T2DM behavior change (Glasgow, Toobert, & Hampson, 1996; Norris, Engelgau, & Narayan, 2001; Wheeler, Wheeler, Ours, & Swider, 1985). Research is needed to develop behavioral programs that promote regular PA. Self-regulation is the ability to modify behavior using: self-monitoring, goal setting, and time management (Bandura, 1991; Biddle & Fuchs, 2009). To date, one study has shown an increase in self-regulation supporting PA behavior in adults with T2DM (Olson & McAuley, 2015). Other studies are limited by not measuring changes in psychosocial variables or producing mixed results in behavior change (Glasgow et al., 1992; Kirk, Barnett, Leese, & Mutrie, 2009; Norris et al., 2001; Plotnikoff et al., 2010; Tudor-Locke et al., 2004). More studies are needed to establish self-regulation as an important construct for PA behavior change (Heiss & Petosa, 2014). The purpose of this pilot study was to examine the effect of a brief behavioral intervention on the use of self-regulation strategies and moderate-to-vigorous physical activity (MVPA) among overweight and obese adults with T2DM. Based on the literature demonstrating the ability to improve self-regulation strategies for other health behaviors, we hypothesized that the intervention group would increase their use of self-regulation strategies and MVPA compared to the control group.

Methods

This study used a pretest-posttest control group design. Participants were recruited using ResearchMatch.org, electronic campus newsletters, and flyers posted in campus buildings and local businesses. Eligible volunteers were adults (≥18 years), diagnosed with T2DM, with a BMI ≥ 25 kg/m^2. Individuals were excluded if they were not physically able to engage in exercise, or if they were currently exercising regularly. Individuals were randomized into either the experimental or control group. The Institutional Review Board at The Ohio State University approved all procedures.

Three researchers received 6 weeks of training prior to the intervention to ensure consistency of implementation across subjects. Researchers were not blinded to participant group. Both groups met individually with a researcher four times over five weeks (Figure 1). The first and second visits were one week apart. Visit three was scheduled two weeks after visit two. The third and fourth visits were one week apart. During the first visit, both groups completed self-regulation measurements and received a BodyMedia armband to wear for seven days.

During the second visit, the intervention group received information regarding their measured PA habits, and a behavioral intervention that included goal setting, time management, and enlisting social support to help participants plan their weekly PA. Participants were given weekly PA logs and pedometers to self-monitor their PA for two weeks. The control group received information regarding their measured PA habits.

At session three, both groups received the BodyMedia armband to wear for seven days. The intervention group reviewed behavioral goals and identified barriers to PA. They set PA goals and self-monitored their PA.

The final visit had both groups completing the posttest self-regulation measurement and receiving information regarding their PA. The control group received written recommendations for PA for adults with T2DM (Colberg et al., 2010), and a pedometer. Total study contact time, including measurement and intervention procedures, was approximately 100 and 60 min for the intervention and control group, respectively.

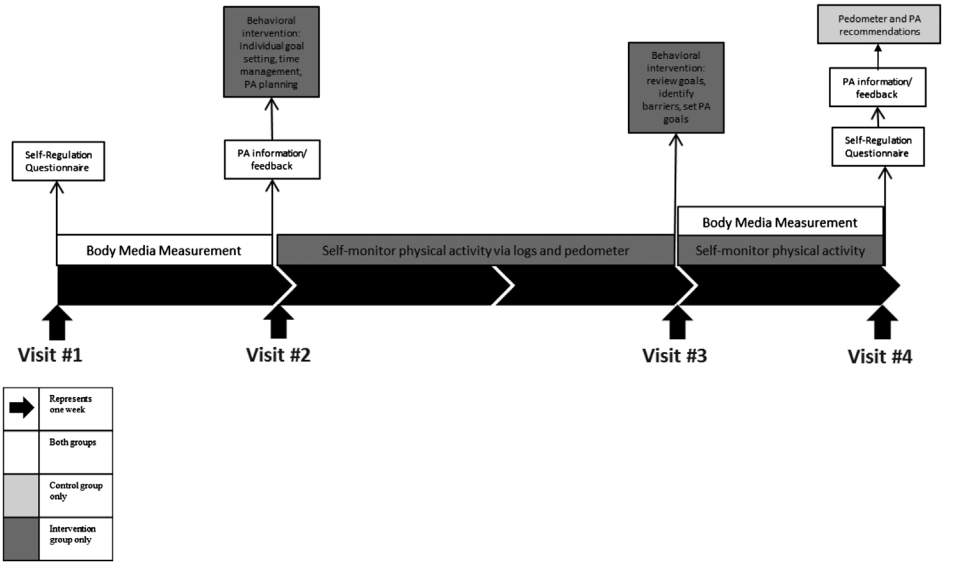

Figure 1. Timeline and diagram of measurement and intervention procedures for intervention and control groups.

Measures

PA was measured with the BodyMedia armband (Internet). Individuals wore the armband for seven days between the first and second (pretest) and third and fourth visits (posttest). The device measured minutes of MVPA, energy expenditure, sedentary time and number of steps, via sensors measuring: movement, heat flux, galvanic skin response, and skin temperature. Test-retest reliability and criterion validity have been established (Berntsen et al., 2010; Brazeau et al., 2011; Internet; Mignault, Onge, Karelis, Allison, & Rabasa-Lhoret, 2005).

On the Self- Regulation for Exercise Scale, participants rated how often they used self-regulation strategies during the past four weeks on a 5-point scale from 'Never' to 'Very Often'. Subscales ($\alpha = .948$) included: self-monitoring ($\alpha = .668$), goal setting ($\alpha = .871$), social support ($\alpha = .793$), self-reward ($\alpha = .874$), time management ($\alpha = .806$), and overcoming barriers ($\alpha = .74$). A 3-stage expert panel review established face and content validity. Subscales were previously refined using confirmatory factor analysis (Hallam & Petosa, 1998).

Statistical analysis

Data analysis was conducted using IBM SPSS Statistics. Inferential statistics were not applied because of the small sample size. Upon inspection for normality, an outlier was observed for baseline minutes of MVPA per week and minutes of MVPA per day. These data points were removed from the analysis of minutes of MVPA per week and minutes of MVPA per day. Number of steps per day, caloric expenditure per day, and sedentary time were retained for this subject. Three Cohen's *d* effect size measures were calculated per dependent variable to examine (Internet) the intervention group changes from pre-to post-test, (Bandura, 1991) the control group changes from pre- to post-test, and (Berntsen et al., 2010) the difference

between the intervention and control group at posttest. An effect size of 0.2 was considered low, 0.5 was considered medium, and 0.8 was large (Vincent, 2005).

Results

Baseline characteristics

A total of 23 participants enrolled in this pilot study (Figure 2). Sixteen were recruited from ResearchMatch.org. Table 1 displays the baseline characteristics for the intervention ($n = 12$) and control ($n = 11$) groups. Both groups were, middle-aged, obese, and a majority female. The pretest and posttest self-regulation and MVPA values for both groups are presented in Tables 2 and 3. There were no differences between groups on any pretest variables.

Effects of the intervention

All effect sizes for MVPA and self-regulation are summarized in Table 4. There was a large effect for the intervention group on total self-regulation (3.15), self-monitoring (4.63), goal setting (3.17), social support (1.29), self-reward (1.98), time management (4.41), and overcoming barriers (2.25). There were also large differences between groups at posttest for total self-regulation (2.43), self-monitoring (3.75), goal setting (1.68), social support (1.33), self-reward (1.45), time management (2.35), and overcoming barriers (1.85).

There was a small effect of the intervention on total minutes of MVPA per week (−.22), minutes of MVPA per day (−.23), caloric expenditure (−.30), and sedentary time (.39) in the intervention group over time. There was a moderate effect on number of steps per day (.57). There were small differences between groups at posttest in caloric expenditure (.26) and sedentary time (.35), and moderate differences in number of steps per day (.77), minutes of MVPA per week (.64), and minutes of MVPA per day (.64).

Discussion

The brief behavioral intervention increased the use of self-regulatory strategies in a sample of overweight and obese adults with T2DM. This is consistent with previous research that successfully improved self-regulation for PA (Heiss & Petosa, 2015; Olson & McAuley, 2015). This study is novel in that few studies have targeted self-regulation to promote PA in adults with T2DM (Glasgow et al., 1992; Kirk et al., 2009; Plotnikoff et al., 2010; Tudor-Locke et al., 2004). This is important because researchers can efficiently target use of self-regulation skills to promote PA.

Minutes of MVPA per week, minutes of MVPA per day, and caloric expenditure decreased in both groups, and time spent being sedentary per day increased over time. The intervention had a positive impact on number of steps per day. The effect of behavioral interventions on MVPA in adults with T2DM has been mixed. Our results were similar to the First Step Program and the ADAPT trial, producing positive changes in number of steps, but no other dimensions of MVPA (Plotnikoff et al., 2010; Tudor-Locke et al., 2004). Other studies that were primarily phone- or Internet-based saw positive changes in PA, but changes were lost at follow-up (De Greef, Deforche, Tudor-Locke, & De Bourdeaudhuij, 2011; McKay, King, Eakin, Seeley, & Glasgow, 2001). It is important to note baseline values

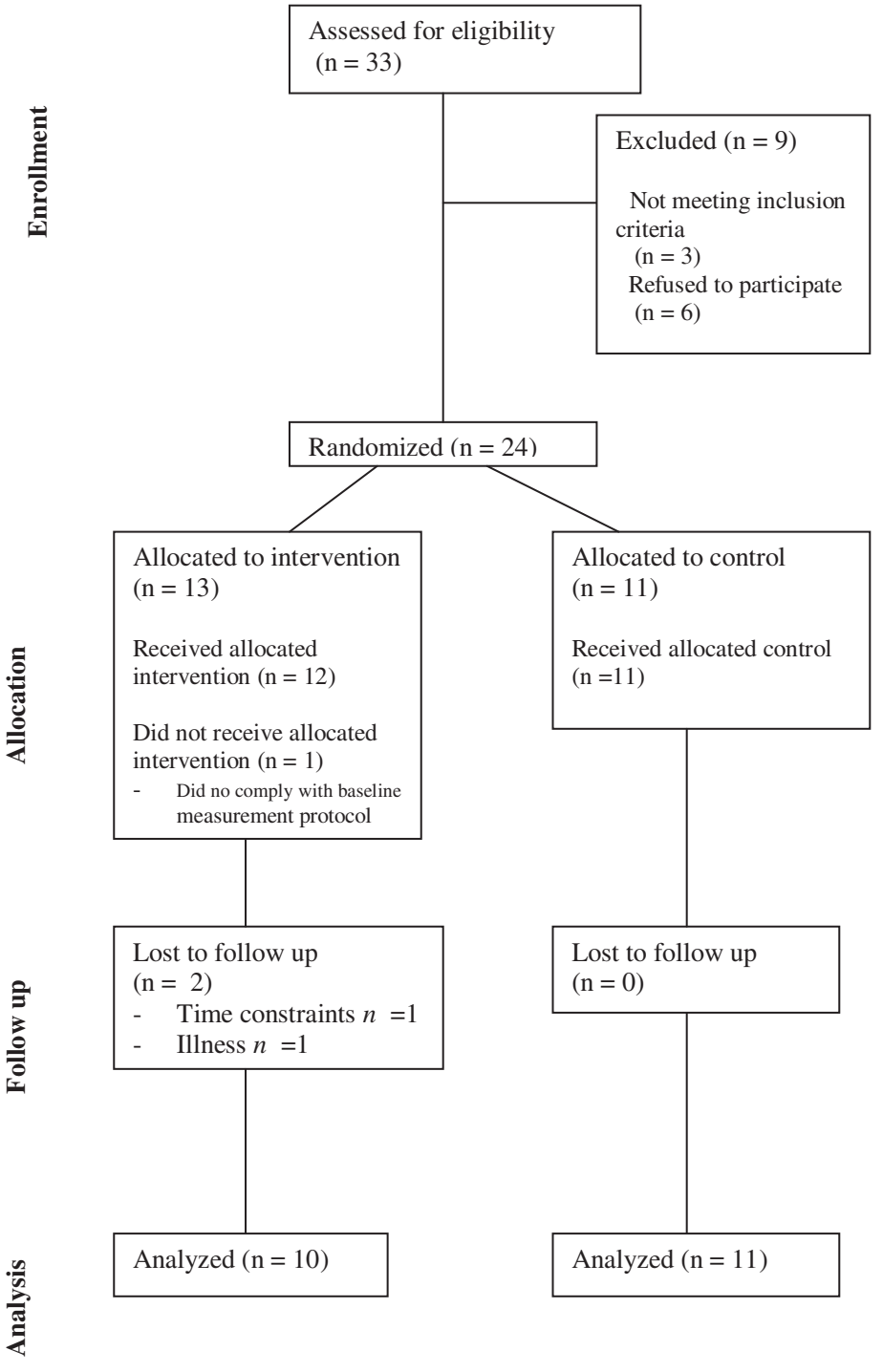

Figure 2. Flow diagram tracking intervention group and control group participants.

for minutes of MVPA per week and minutes of MVPA per day in both groups suggest that the individuals were meeting PA guidelines prior to the start of the intervention (Colberg et al., 2010). This is inconsistent with national data suggesting only 31% of adults with

Table 1. Baseline characteristics for the intervention and the control group.

	Intervention (n = 12)	Control (n = 11)
Age, mean (SD)	57.75 (9.818)	57.09 (9.093)
BMI, mean (SD)	34.38 (4.38)	39.5 (8.89)
Gender, n (%)		
Female	9 (75)	7 (63.6)
Male	3 (25)	4 (36.4)
Race, n (%)		
White	7 (58.3)	10 (90.9)
Black or African American	4 (33.3)	1 (9.1)
Other	1 (8.3)	0 (0)
Ethnicity, n (%)		
Hispanic or Latino	0 (0)	1 (9.1)
Not Hispanic or Latino	12 (100)	10 (90.9)
Martial Status, n (%)		
Single	1 (8.3)	2 (18.2)
Married/Partnered	8 (66.7)	7 (63.6)
Divorced	2 (16.7)	2 (18.2)
Widowed	1 (8.3)	0 (0)
Education, n (%)		
High School Diploma	0 (0)	1 (9.1)
Some College	6 (50)	3 (27.3)
College Degree	4 (33.3)	5 (45.5)
Graduate Degree	1 (8.3)	2 (18.2)
Professional Degree	1 (8.3)	0 (0)

Table 2. Pretest and posttest values for dimensions of self-regulation for the intervention group and the control group.

	Pretest		
	Intervention $M \pm SD$	Control $M \pm SD$	d
Total self-regulation	1.63 ± 0.59	1.85 ± 0.59	0.37
Self-monitoring	1.56 ± 0.61	1.87 ± 0.75	0.45
Goal setting	1.78 ± 0.80	2.04 + 0.95	0.31
Social support	1.42 ± 0.54	1.48 + 0.57	0.11
Self-reward	1.89 ± 0.76	2.10 ± 0.88	0.26
Time management	1.42 ± 0.66	1.70 ± 0.67	0.42
Overcoming barriers	1.51 ± 0.52	1.79 ± 0.56	0.51
	Posttest		
Total self-regulation	3.49 ± 0.59	2.02 ± 0.61	
Self-monitoring	4.24 ± 0.55	1.98 + 0.65	
Goal setting	3.99 ± 0.60	2.49 + 1.11	
Social support	2.59 ± 1.16	1.43 ± 0.43	
Self-reward	3.45 ± 0.81	2.35 + 0.70	
Time management	3.75 ± 0.75	2.02 + 0.73	
Overcoming barriers	3.36 ± 1.04	1.78 + 0.62	

T2DM meet PA guidelines (Nelson et al., 2002), and suggests that a ceiling effect may have resulted in the inability of MVPA minutes per week or per day to increase beyond baseline. Although participants reported being inactive prior to the study, they were motivated change increase PA. It is possible that research protocol produced reactive effects resulting in inflated baseline values of MVPA. The findings of this study suggest that intervention increased steps of walking per day, but did little to improve other dimensions of MVPA.

Table 3. Pretest and posttest values for dimensions of PA for the intervention group and the control group.

	Pretest		
	Intervention *M* ± SD	Control *M* ± SD	*d*
Minutes of MVPA per week	411.33 ± 281.52	304.45 ± 327.08	0.35
Minutes of MVPA per day	59.22 ± 39.75	44.09 ± 46.36	0.35
Steps per day	4594.5 ± 2660.81	3915.09 ± 2635.77	0.26
Caloric expenditure per day (kcal)	2666.1 ± 666.47	2840.91 ± 461.90	0.30
Sedentary time per day (hour:min)	21:49 ± 1:36	22:16 ± 1:00	0.34
	Posttest		
Minutes of MVPA per week	352.44 ± 254.24	187.27 ± 266.25	
Minutes of MVPA per day	50.44 ± 36.40	26.64 ± 37.87	
Steps per day	6214.79 ± 2982.10	4108 ± 2475.44	
Caloric expenditure per day (kcal)	2487.79 ± 497.36	2610.73 ± 431.55	
Sedentary time per day (hour:min)	22:22 ± 1:09	22:45 ± 1:03	

Table 4. Effect sizes for differences in the intervention (***d***1) and control groups (***d***2) from pretest to posttest, and differences between groups at posttest (***d***3).

	*d*1	*d*2	*d*3
Dimensions of MVPA			
Minutes of MVPA per week	−0.22	−0.39	0.64
Minutes of MVPA per day	−0.23	−0.41	0.64
Number of steps per day	0.57	0.08	0.77
Caloric expenditure per day	−0.30	−0.52	0.26
Sedentary time per day	0.39	0.47	0.35
Dimensions of self-regulation			
Total self-regulation	**3.15**	0.28	**2.43**
Self-monitoring	**4.63**	0.16	**3.75**
Goal setting	**3.17**	0.44	**1.68**
Social support	**1.29**	0.10	**1.33**
Self-reward	**1.98**	0.31	**1.45**
Time management	**4.41**	0.46	**2.35**
Overcoming barriers	**2.25**	0.02	**1.85**

Note. Bold values represent large effect sizes ($d > 0.8$).

A limitation to this study is low power due to a small sample size, limiting the ability to perform inferential statistics. These results should be viewed as preliminary, and the effect sizes obtained from this pilot study can serve to inform the design of subsequent, optimally powered trials using this intervention. Another limitation is that we recruited motivated volunteers, not randomly selected from the population. Results from this study should not be generalized beyond this sample. Finally, the measures of MVPA should be considered within the limitations of the BodyMedia. First, this device cannot differentiate bouts of PA. Also, individuals were not meeting the guidelines for the number of steps per day at baseline despite adequate minutes of MVPA. The discrepancy between minutes per day and steps per day requires further examination. Given that the BodyMedia is worn on the arm, it may have overestimated MVPA by recording upper body movements independent of full body activity or steps.

This pilot study provided preliminary evidence that a brief behavioral intervention can have a meaningful effect on the use of self-regulation strategies among a sample of overweight and obese adults with T2DM. However, this study did not have a meaningful impact on dimensions of MVPA. Given the importance of regular PA for adults with T2DM, it is

important to develop effective programs to promote PA adherence. Future studies should focus on reducing pretest ceiling effects on PA and replicate the intervention to promote the use of self-regulation skills.

Disclosure statement

No potential conflict of interest was reported by the authors.

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