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ORIGINAL ARTICLE

Physical Activity Can Enhance Life (PACE-Life): results from a 10-week walking intervention for individuals with schizophrenia spectrum disorders

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ABSTRACT

Background: Premature mortality in individuals with schizophrenia spectrum disorders (SSDs) is largely due to high rates of chronic health conditions. Although exercise has been shown to improve health in this population, scalable and accessible interventions are limited.
Aim: To examine the impact of Physical Activity Can Enhance Life (PACE-Life), a novel walking intervention, on physical activity, and on secondary outcomes of cardiorespiratory fitness (CRF), physical health, autonomous motivation, social support, and quality of life.
Method: Sixteen individuals with SSDs were enrolled in a 10-week open trial. The intervention included walking groups, home-based walks, Fitbit use, and goal-setting and if-then plans. Within-group effect sizes were calculated to represent changes from baseline to post-test and 1-month follow-up.
Results: Participants increased self-reported weekly walking minutes and decreased daily hours spent sitting; however, Fitbit-recorded exercise behavior changed only minimally. There were also improvements in secondary outcomes including autonomous motivation and hip circumference. CRF improved only minimally, and findings were relatively unchanged with outliers removed from the full sample.
Conclusions: This open trial demonstrates modest improvements in key parameters of exercise behavior and physical health from participating in PACE-Life. Future research should assess the efficacy of this intervention in a randomized controlled trial.

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Schizophrenia; exercise; health; intervention; physical activity

Introduction

Premature mortality of individuals with schizophrenia spectrum disorders (SSDs) represents a grave public health concern (Brown et al., 2000; Hjorthøj et al., 2017; Lee et al., 2018) and is largely attributable to chronic, yet preventable, physical health conditions (Brown et al., 2010; Laursen, 2011). Compared to the general population, individuals with SSDs are more likely to smoke and less likely to be physically active (McCreadie, 2003; Vancampfort et al., 2017; Wildgust & Beary, 2010). They are also particularly susceptible to other risk factors for mortality, including elevated glucose, high blood pressure and cholesterol, and obesity (Connolly & Kelly, 2005; Glover et al., 2013; Hennekens et al., 2005; World Health Organization, 2009). These risk factors are associated with increased rates of chronic medical conditions, particularly cardiovascular disease, both in individuals with SSDs and in the general population (Brown et al., 2000; Connolly & Kelly, 2005; Goff et al., 2005; Vancampfort et al., 2017).

Increasing physical activity among those with SSDs offers a promising approach for addressing these modifiable risk factors and existing research has yieleded promising findings (Daumit et al., 2013; Dauwan et al., 2016; Firth et al., 2015; Rosenbaum et al., 2014). Specifically, controlled trials (e.g., Heggelund et al., 2011) and randomized controlled trials (e.g., Ospina et al., 2019; Scheewe et al., 2012) have demonstrated that interventions targeting cardiorespiratory fitness (CRF) through muscle strength exercises and/or interval training are particularly effective. Yet, the limited feasibility and sustainability of many existing interventions precludes their widespread implementation. Individuals with SSDs face a number of barriers to engage in regular physical activity that must be addressed in order for interventions to be both feasible and sustainable. Specifically, many individuals with SSDs do not engage in regular physical activity due to stress and depressive symptoms (Firth et al., 2016; Klingaman et al., 2014; Rastad et al., 2014), limited social support and decreased motivation (Browne et al., 2016; Farholm & Sørensen, 2016; Firth et al., 2016; Johnstone

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et al., 2009; Klingaman et al., 2014), and an inability to afford or safely access resources such as gyms (McDevitt, et al., 2006; Rastad et al., 2014). Therefore, it is imperative to develop physical activity interventions for individuals with SSDs that are not only effective but also accessible and viable in the long-term.

Walking serves as a practical method to increase physical activity in individuals with SSDs, as it can be performed anywhere without need for specialized training, equipment, or exercise facilities. Further, walking interventions have been shown to be safe for individuals with SSDs (Bernard et al., 2015; Soundy et al., 2014) and effective at improving health outcomes in the general population (Kelly et al., 2014). However, limited motivation remains a barrier to engagement for this population even in walking interventions, which suggests the need for additional strategies to address such concerns. Self-determination theory (SDT; Deci & Ryan, 2008; Ryan & Deci, 2000) offers a valuable framework for conceptualizing motivation and has successfully informed the development of exercise interventions aimed at increasing physical activity (Chatzisarantis & Hagger, 2009; Hsu et al., 2013; Sheeran et al., 2020; Silva et al., 2010). SDT emphasizes the importance of fulfilling three basic psychological needs: autonomy, relatedness, and competence (Ryan & Deci, 2000). Fulfillment of these needs may in turn lead to autonomous or self-determined motivation (i.e., the extent to which a behavior is prompted by intrinsic rather than extrinsic reasons), which plays an important role in exercise initiation and adoption in the general population (Teixeira et al., 2012) and in those with SSDs (Vancampfort et al., 2013).

In order to address these issues, we developed Physical Activity Can Enhance Life (PACE-Life), a novel multicomponent walking intervention rooted in SDT, with each component mapping onto the basic psychological needs. In this paper, we report on the results of an initial open trial of PACE-Life. The aims of the present study were to examine the impact of PACE-Life on (1) primary outcomes of physical activity participation (steps/day and minutes spent walking) and (2) secondary outcomes of fitness (six-minute walk test), physical health (weight, hip/waist circumference), autonomous motivation to exercise, social support, and quality of life. In addition, the study aimed to assess feasibility, acceptability, and satisfaction through group attendance and Fitbit adherence rates, as well as participant feedback.

Method

Participants

A total of 16 individuals with SSDs were enrolled in two cohorts (Cohort 1: $n = 9$; Cohort 2: $n = 7$) that took place consecutively at the local outpatient community mental health center. The small size of each cohort allowed for a higher ratio of group leaders to participants, making groups more manageable and maximizing interaction between group leaders and participants. The Institutional Review Board at a large public university in the Southeast United States approved this study and all participants provided written informed consent. Participants were primarily Caucasian (81.3%) and male (87.5%). Mean age was 38.06 years ($SD = 10.55$ years) although participants in Cohort 1 ($M = 45.44$, $SD = 10.55$) were significantly older than those in Cohort 2 ($M = 31.14$, $SD = 5.52$; $t(14) = 3.24$, $p < .01$; Table 1). All participants met the following inclusion criteria: (a) DSM-V diagnosis of a Schizophrenia Spectrum Disorder; (b) age 18 or above; (c) clinically stable (i.e., no psychiatric hospitalizations in the previous three months and no psychiatric medication changes within the past month); (d) receiving treatment for psychosis for at least two years; (e) not already engaging in regular moderate-intensity physical activity (cutoff = 60 min/week for the past 6 months); (f) presented with no contraindication to engage in regular moderate intensity exercise based on the Physical Activity Readiness Questionnaire (PAR-Q; Pescatello, 2014). A cutoff of 60 min per week for the past six months was used to minimize the potential effects of participants with higher levels of physical activity on the main outcome variable physical activity levels, and the effect of increasing physical activity levels throughout the study on different health outcomes.

Intervention

PACE-Life comprises several key elements that map onto the SDT basic needs: (1) moderate-intensity group-based walking (targeting relatedness), (2) moderate-intensity

Table 1. Participant demographic and clinical characteristics.

	Cohort 1 ($N = 9$)		Cohort 2 ($N = 7$)		All Participants ($N = 16$)	
Characteristic	*n*	%	*n*	%	*n*	%
Male	9	100	5	71.4	14	87.5
Race						
Caucasian	7	77.8	6	85.7	13	81.3
African American	1	11.1	1	14.3	2	12.5
Other	1	11.1	0	0.0	1	6.3
Ethnicity						
Hispanic	2	22.2	0	0.0	2	12.5
Non-Hispanic	7	77.8	7	100	14	87.5
Diagnosis						
Schizophrenia	3	33.3	3	42.9	6	37.5
Schizoaffective	6	66.7	3	42.9	9	56.3
Psychosis NOS	0	0.0	1	14.3	1	6.3
Employment status						
Unemployed	7	77.8	3	42.9	10	62.5
Employed part-time	2	22.2	3	42.9	5	31.3
Employed full-time	0	0.0	1	14.3	1	6.3
Education level						
High school	2	22.2	2	28.6	4	25.0
Some college	1	11.1	4	57.1	5	31.3
College degree	5	55.6	1	14.3	6	37.5
Higher than college	1	11.1	0	0.0	1	6.3
	Mean	SD	Mean	SD	Mean	SD
Age (yrs)	45.44	10.55	31.14	5.52	38.06	10.55
Education (yrs)	15.11	2.03	13.57	1.13	14.44	1.82
BMI	31.51	4.16	28.70	6.55	30.20	5.40

Note: One participant who dropped out of the study during Cohort 1 was included in the demographic table but removed from further analyses.
Note: Samples did not significantly differ in regard to gender ($\chi^2 = 2.33$, $p > .05$), race ($\chi^2 = 2.23$, $p > .05$), ethnicity ($\chi^2 = 2.30$, $p > .05$), employment status ($\chi^2 = 2.87$, $p > .05$), diagnosis ($\chi^2 = 2.29$, $p > .05$), or level/years of education ($\chi^2 = 8.82$, $p > .05$ and $t(14) = 1.79$, $p > .05$). In contrast, participants involved in Cohort 1 were significantly older than participants in Cohort 2 (Mean Difference = 14.30 years, SD = 4.41; $t(14) = 3.24$, $p < .01$).

home-based walking (targeting autonomy), (3) activity tracking using Fitbit (targeting competence), and (4) goal-setting (targeting competence). If-then plans (described below) were added after the completion of Cohort 1 to enhance goal-setting procedures given evidence of the efficacy of targeting implementation intentions to change physical activity (e.g., Bélanger-Gravel et al. 2013). As such, only Cohort 2 received this component of the intervention. The intervention was designed to last 10 weeks, however, the program spanned 11 weeks for Cohort 1 due to scheduling issues around holidays (Note: both cohorts received 20 walking groups total).

Walking groups took place twice per week (on fixed days) for 30 min each and were led by undergraduate and graduate student research assistants. All group leaders were trained to follow standardized protocols (e.g., asking participants to check their heart rates at specific times throughout the session) and encouraged participants to walk together when possible. Stepwise intensity progression (i.e., gradually increasing the rigor of the exercise through heart rate monitoring) was utilized to ease participants into the walking program and to maximize health benefits (Garber et al., 2011). Each week, participants were given a card indicating their target heart rate (HR) zone and were encouraged to walk at a pace that allowed them to achieve the level of intensity necessary to remain in the target zone range. Target HR zones were calculated using percentages of the Heart Rate Reserve (HRR) through the Karvonen method (Díaz-Buschmann et al., 2014) that steadily progressed over the course of the intervention to create an exercise dose-response. This stepwise approach has been shown to decrease risk of injury and reduce dropout rates in sedentary populations and has been successfully implemented in samples with SSDs (Kimhy et al., 2015; Scheewe et al., 2012).

In the second session each week, participants set weekly goals that included a target number of daily steps, as well as a detailed approach for home-based intensity walks. Participants specified for a given week the intended frequency, locations, target HR zone, and days and times for intensity walks. Participants in Cohort 2 also completed weekly if-then plans, wherein participants anticipated potential barriers to exercise and preemptively generated potential solutions (e.g., “If I am feeling too tired to go on my walk, then I will remind myself that I will feel more energized after walking”). If-then plans are an effective tool for translating motivation into action, particularly with regard to physical activity (Armitage & Arden, 2010; Gollwitzer & Sheeran, 2006; Latimer et al., 2006; Marquardt et al., 2017).

Materials

Participants completed assessments at baseline, post-treatment, and 1-month follow-up. Participants in Cohort 1 also completed an assessment at mid-treatment (after 5 weeks) which included similar measures to baseline and post-treatment assessments (described below). In this article, we report only on measures administered for both cohorts at the three overlapping time points (i.e., baseline, post-treatment, and 1-month follow-up). Trained graduate student research assistants administered all assessment measures.

Physical health and exercise

Fitbit Charge HR physical activity trackers were utilized to measure total number of daily steps, minutes spent walking, and heart rate during exercise, as Fitbit devices have been successfully used for tracking physical activity in this population (Naslund et al., 2016). Steps were automatically recorded gat all times the Fitbit device was worn. Minutes spent walking included any physical activity automatically or manually recorded by the Fitbit device lasting for 15 or more continuous minutes. The Short Form International Physical Activity Questionnaire (IPAQ; Craig et al., 2003) was administered as a self-report measure of physical activity (weekly walking minutes) and sedentary behavior (daily hours spent sitting). The IPAQ has been validated in samples with schizophrenia and demonstrates psychometric properties comparable to those shown in the general population (Faulkner et al., 2006).

Autonomous motivation towards exercise was assessed using the Behavioral Regulation in Exercise Questionnaire-2 (BREQ-2; Markland & Tobin, 2004), a 19-item measure that produces five subscales and a relative autonomy index (RAI; Ryan & Connell, 1989). The RAI is calculated based on BREQ-2 weighted subscale scores and serves as a single score indicator of self-determination (higher scores indicate greater relative autonomy). Thus, BREQ-RAI scores, rather than subscale scores, were included in analyses in order to assess successful operationalization of SDT constructs.

Heart rate, blood pressure, weight, height, and waist/hip circumference were evaluated as biological measures of physical health. The Six-Minute Walk Test (6MWT; Vancampfort et al., 2011) was administered in order to provide a determinant of CRF as a surrogate assessment of the functional status of the cardiopulmonary and skeletal muscle systems and overall fitness. The 6MWT requires individuals to walk continuously for six minutes on a flat, indoor surface around cones (separated by 100 feet), and the total distance walked is recorded, providing information regarding the individual’s aerobic capacity. The 6MWT has been administered and recommended for use in samples with SSDs (e.g., Marzolini et al., 2009; Vancampfort et al., 2011).

Mental health and wellbeing

The Multidimensional Scale of Perceived Social Support (MSPSS; Zimet et al., 1990) is a 12-item self-report questionnaire that assesses social support from family, friends, and significant others, as perceived by the individual. Given the nature of the study, we expected that any changes in social support from family or significant others would be due to external reasons; as such, only the friends subscale was included in analyses. The World Health Organization Quality of Life Scale (WHOQOLBREF; Skevington et al., 2004) is a self-report questionnaire that assesses quality of life in four domains: physical health, psychological health,

Table 2. Within-group change in primary outcomes.

	All participants ($n = 15$)	Outliers removed ($n = 13$)
Fitbit: Steps/day		
BL, M(SD)	9518.25(5639.04)[e]	7764.88(2596.84)[c]
PT, M(SD)	9851.50(5773.51)[d]	8174.33(4105.32)[b]
FU, M(SD)	9857.99(6691.81)[c]	7961.82(4203.71)[a]
BL-PT *d*	0.03	0.12
BL-FU *d*	−0.10	−0.20
Fitbit: Total weekly walking minutes		
BL, M(SD)	202.5(342.52)[e]	111.08(119.59)[c]
PT, M(SD)	224.15(328.23)[d]	179.73(340.85)[b]
FU, M(SD)	119.17(256.27)[c]	127.25(280.10)[a]
BL-PT *d*	0.01	0.25
BL-FU *d*	−0.44	−0.12
IPAQ: Total weekly walking minutes		
BL, M(SD)	366.43(743.26)[e]	252.50(594.40)[c]
PT, M(SD)	931.00(1298.05)	743.08(990.01)
FU, M(SD)	653.21(1046.00)[e]	687.31(1080.58)[d]
BL-PT *d*	0.53	0.57
BL-FU *d*	0.34	0.33
IPAQ: Total daily sitting hours		
BL, M(SD)	8.36(5.01)[d]	9.20(4.98)[b]
PT, M(SD)	6.07(3.16)	6.42(3.21)
FU, M(SD)	6.43(4.13)[e]	6.50(4.29)
BL-PT *d*	0.55	0.58
BL-FU *d*	0.47	0.58

Note: BL = Baseline, PT = Post-test, FU = Follow-up, *d* = Effect size, IPAQ = International Physical Activity Questionnaire - Short Form. Sample sizes for reported means and effects sizes differ for some outcomes (see below). All Cohen's *d* values represent magnitude of the group mean change based on pooled standard deviations from baseline. Positive effect sizes reflect improvements whereas negative effect sizes indicate deterioration. BL Fitbit steps and walking minutes are from week 1 of the intervention and post-treatment are from the final week of the intervention (Week 11 for Cohort 1 and Week 10 for Cohort 2). Total Minutes Walking for the FU period (4 weeks) were calculated by dividing the total walking minutes by four in order to obtain a weekly average comparable to the BL and PT period data.
[a]$n = 10$.
[b]$n = 11$.
[c]$n = 12$.
[d]$n = 13$.
[e]$n = 14$.

social relationships, and environment. Items 1 and 2 assess participants' overall perceptions of their quality of life and their health respectively; these two items were examined separately in analyses per scoring instructions (World Health Organization, 1996).

Participant feedback and satisfaction

The Client Satisfaction Questionnaire (CSQ-8; Attkisson & Zwick, 1982; Larsen et al., 1979), is an 8-item measure of client satisfaction. This measure was tailored to the present intervention (e.g., changing the word "services" to "exercise program"). Additionally, clients completed a feedback questionnaire developed by the research team with multiple choice and free response questions regarding specific components of the intervention. Specifically, the feedback form assessed reasons for group attendance/non-attendance, ratings of intervention components, and global feedback about the program.

Procedure

During the baseline assessment, participants received a Fitbit device and were provided with information regarding proper use and charging. Participants were instructed to wear the Fitbit at all times except while showering. For each walking group, two student co-leaders met participants at the clinic, distributed HR zone cards, supplied water bottles, and provided umbrellas when needed. Leaders then led the group on a walk around the area surrounding the clinic. Fitbits were synced to each participant's Fitbit account before, during, or after each group session. During the walk, participants were reminded periodically to check HR using their Fitbit devices and encouraged to adjust their pace in order to keep their HR within their individual target zones. Leaders moved around the group, with one leader generally walking alongside faster participants, and the other leader generally walking alongside those walking at a slower pace. Leaders also encouraged participants to walk together and encouraged faster participants to "double back" when necessary to remain close to those who walked more slowly. After 30 minutes, the group returned to the clinic and group leaders facilitated a brief check-in about the walk. Goal-setting and if-then plans sessions were conducted in a private space after the second walking group each week.

Data analysis

Given the small sample size of the study ($N = 16$), analyses were primarily descriptive. Although cohorts differed significantly with regard to age and some components of the intervention (e.g., Cohort 2 received if-then plans), we chose to combine cohorts due to the small sample size. Additionally, due to variability among participants in baseline levels of physical activity and the possibility that this may affect outcomes, additional analyses were conducted excluding participants with elevated levels of baseline physical activity. To do this, individuals who walked at or above 12,500 steps during the first week ($N = 2$) were considered "highly-active" and were excluded from additional analyses. This value was chosen given that it has been shown to differentiate between "active" and "highly-active" groups when examining a dose-response relationship between physical activity and health outcomes (Tudor-Locke & Bassett, 2004; Tudor-Locke et al., 2008).

Means and standard deviations for each outcome variable were calculated based on all available data at a given time point. Effect sizes (Cohen's *d*) were computed for all continuous outcome variables in order to evaluate changes from baseline to post-treatment and baseline to follow-up. Effect sizes were calculated using group means for all participants with data available at the two time points in question (i.e., baseline and post-treatment or baseline and follow-up), and dividing the change in group means by the pooled standard deviation (Lakens, 2013). Effect sizes were evaluated as small ($d = .20$), medium ($d = .50$), and large ($d = .80$; Cohen, 1988).

Program satisfaction was assessed by evaluating group attendance, Fitbit adherence, and CSQ-8 total scores. Group attendance was calculated first for each participant based on the total number of groups they attended divided by the number of groups they were eligible to attend (based on

Table 3. Within-group change in secondary outcomes.

	All participants ($n = 15$)	Outliers removed ($n = 13$)
Physical health outcomes		
6MWT (ft)		
BL, M(SD)	1654.76(269.36)	1609.04(223.97)
PT, M(SD)	1698.63(304.11)	1644.58(253.15)
FU, M(SD)	1665.68(185.02)[b]	1670.35(191.71)[a]
BL-PT *d*	0.15	0.15
BL-FU *d*	0.28	0.29
RHR		
BL, M(SD)	91.20(14.89)	93.77(14.28)
PT, M(SD)	96.47(12.94)	99.00(11.85)
FU, M(SD)	94.29(13.38)[b]	95.08(13.59)[a]
BL-PT *d*	−0.38	−0.40
BL-FU *d*	−0.12	−0.09
BP (SBP/DBP)		
BL, M(SD)	129/85(13.68/9.41)	129/86(14.59/9.38)
PT, M(SD)	127/85(13.49/8.79)	126/85(14.16/8.72)
FU, M(SD)	124/83(12.46/8.21)[b]	123/82(12.91/8.54)[a]
BL-PT *d*	0.17/0.02	0.17/0.11
BL-FU *d*	0.38/0.27	0.39/0.40
Weight (lbs)		
BL, M(SD)	204.10(41.68)	209.87(41.90)
PT, M(SD)	201.95(41.98)	208.95(40.44)
FU, M(SD)	206.19(41.73)[b]	208.97(41.28)[a]
BL-PT *d*	0.05	0.02
BL-FU *d*	0.02	0.02
Waist/Hip Circumference (cm)		
BL, M(SD)	105/112(16.12/10.14)	108/114(14.76/9.71)
PT, M(SD)	104/107(17.05/10.74)	108/109(15.57/10.01)
FU, M(SD)	107/110(14.92/10.74)[b]	109/111(14.21/11.04)[a]
BL-PT *d*	0.06/0.49	0.05/0.48
BL-FU *d*	−0.05/0.29	−0.04/0.29
Psychological outcomes		
BREQ-RAI		
BL, M(SD)	8.61(5.92)	7.96(6.08)
PT, M(SD)	10.66(5.03)	10.44(5.38)
FU, M(SD)	9.95(6.07)[b]	9.66(6.22)[a]
BL-PT *d*	0.37	0.43
BL-FU *d*	0.25	0.27
MSPSS Friends		
BL, M(SD)	6.03(0.99)	5.86(1.09)
PT, M(SD)	4.93(1.88)	4.91(1.65)
FU, M(SD)	5.27(1.49)[b]	5.15(1.28)[a]
BL-PT *d*	−0.73	−0.78
BL-FU *d*	−0.55	−0.59
WHOQOL-BREF: Perceived QoL		
BL, M(SD)	3.67(0.98)	3.62(1.04)
PT, M(SD)	3.79(0.89) [b]	3.77(0.93)
FU, M(SD)	3.79(0.97)[b]	3.77(1.01)
BL-PT *d*	0.13	0.16
BL-FU *d*	0.12	0.15
WHOQOL-BREF: Perceived Health		
BL, M(SD)	3.13(1.30)	3.15(1.40)
PT, M(SD)	3.29(1.07) [b]	3.31(1.11)
FU, M(SD)	3.21(1.19)[b]	3.23(1.24)
BL-PT *d*	0.13	0.12
BL-FU *d*	0.06	0.06

Note: BL = Baseline, PT = Post-test, FU = Follow-up, *d* = Effect size, 6MWT = six minute Walk Test, RHR = Resting Heart Rate, BP = Blood Pressure (SBP = Systolic; DBP = Diastolic), BREQ-RAI = Behavioral Regulation in Exercise Questionnaire – Relative Autonomy Index, QoL = Quality of Life, MSPSS Friends = Multidimensional Scale of Perceived Social Support – Friends Subscale. Sample sizes for reported means and effects sizes differ for some outcomes (see below). All Cohen's *d* values represent magnitude of the group mean change based on pooled standard deviations from baseline. Positive effect sizes reflect improvements whereas negative effect sizes indicate deterioration.
[a] $n = 12$.
[b] $n = 14$.

enrollment date and eligibility criteria). Then, a group average was calculated across participants. Fitbit adherence was defined as the percentage of days on which Fitbit data was not missing and was calculated using the same procedure used to calculate attendance rates. Finally, we examined information provided by participants on feedback forms.

Results

One participant discontinued participation in the study after the first week and did not complete post-test or follow-up assessments. This participant was excluded from all analyses, leaving a sample size of 15 participants. Tables two and three include raw means and standard deviations using all available data whereas effect sizes (and mean changes included in text below) reflect participants that had data from both timepoints.

Primary outcomes

All participants

From baseline to posttest, the total sample demonstrated medium effect size (ES) improvements in self-reported weekly minutes spent walking, (mean change = 571 minutes) as well as self-reported daily hours spent sitting (mean change = 2.3 h). From baseline to follow-up, small ES improvements were observed in both self-reported minutes spent walking and self-reported hours spent sitting, but small ES decreases were observed in Fitbit-recorded weekly walking minutes at follow-up. Little change was observed in Fitbit-recorded minutes spent walking at posttest, or in the number of daily steps at either time point (Table 2).

Highly-active participants excluded

When excluding highly-active participants, we observed effect sizes similar to those seen in the overall sample, with the following exceptions: from baseline to post-test, small ES improvements were observed in Fitbit-recorded minutes spent walking, and from baseline to follow-up, small ES decreases were observed in daily steps.

Secondary outcomes

Physical health outcomes

All participants. Analyses revealed minimal change in CRF, as measured by the 6MWT, from baseline to posttest, and small ES improvements in CRF from baseline to follow-up. Medium ES improvements in hip circumference were observed at posttest (mean change = 5.1 cm), and small ES improvements were seen at follow-up. Small ES improvements were also observed in systolic and diastolic blood pressure at follow-up. Little to no change was observed in blood pressure at posttest, nor in waist circumference or weight at either time point. A small ES increase in resting heart rate was observed at posttest, and little change was observed in resting heart rate at follow-up (Table 3).

Psychological outcomes

All participants. Overall, small ES improvements were seen in autonomous motivation, as measured by the BREQ-RAI, at both posttest and follow-up. At both time points, moderate ES deterioration in social support, as measured by the MSPSS (posttest mean change = 1.1; follow-up mean change = 0.7), and little to no change in quality of life was observed (Table 3).

Highly-active participants excluded

For all secondary outcomes, when excluding highly-active participants, we observed effect sizes similar to those seen in the overall sample.

Acceptability and feasibility

The overall group attendance rate was 65%. Fitbit adherence rate was 81% during the active intervention and 52% during the one-month follow-up period. Participants were able to increase their exercise intensity over the course of the intervention (25% HRR at Week 1 to 32% HRR at Week 10/11); however, these rates did not reach the recommended levels (Week 1 recommendation: 50–60%; Week 10/11 recommendation: 65–70%).

Total scores on the CSQ-8 indicate high client satisfaction ($M = 28.4$; maximum possible score is 32). Participant feedback regarding specific components of the intervention (e.g., Fitbit use, goal-setting) indicated moderate to high levels of acceptability (Table 4). Notably, participants showed high levels of satisfaction with Fitbit use and reported that they were likely to continue using the device beyond the duration of the study. Results also indicated moderate to high satisfaction with receiving feedback on progress the previous week. Regarding motivation to attend groups, social interaction and health benefits were rated as moderately motivating.

Discussion

The present study examined the effect of PACE-Life on physical activity participation, physical health and fitness, autonomous motivation to exercise, social support, and quality of life. Additionally, we assessed acceptability and satisfaction through group attendance, Fitbit adherence rates, and participant feedback.

Participants experienced moderate improvements in self-reported minutes spent walking and hours spent sitting, with minimal changes in Fitbit-recorded activity. The decrease in hours spent sitting daily, which was maintained at follow-up, is important given that individuals with schizophrenia engage in high rates of sedentary behavior, which is related to negative health outcomes (Stubbs et al., 2016). Despite high activity levels at the start of the intervention, participants slightly increased their activity during the intervention, but then decreased their activity over the follow-up period. As the intervention focused primarily on exercise at a specific intensity, rather than solely accumulating steps, the average number of daily steps increased only minimally. This marginal change may have also been impacted by the relatively high step count seen in this sample at week 1 ($M = 9,518$ steps/day).

With regard to CRF, we observed small ES improvement at follow-up; however, the magnitude of change is likely not clinically meaningful. This finding contrasts with previous 10- to 16-week exercise studies with individuals with SSDs (Beebe et al., 2005; Browne et al., 2016; Marzolini et al., 2009) and may be largely due to the relatively physically active sample that participated in PACE-Life. However, the 6MWT distances at all time points in this study are within the range observed in a systematic review of the 6MWT in individuals with schizophrenia (Bernard et al., 2015). Given that CRF is a critical indicator of physical health, future modifications to the present intervention should be considered in order to maximize the potential impact on this variable.

There were minimal changes in physical health measures including resting HR, blood pressure, weight, and waist/hip circumference. There were some small improvements in blood pressure at follow-up, although these changes are of unclear clinical significance given the short duration of the study. Taken together, these data highlight the importance of better understanding the physical health benefits of moderate intensity walking in people with SSDs. In terms of psychological outcomes, participants experienced increased autonomous motivation for exercise over the intervention period and these gains were mostly maintained at follow-up. This improvement is consistent with the goals of the intervention, which are rooted in SDT. This change in autonomous motivation is particularly encouraging given research suggesting the importance of self-determination in health behaviors for those with SSDs (Vancampfort et al., 2013). Yet, the minimal change in overall quality of life observed in this trial is surprising, particularly given findings that exercise can improve quality of life in participants with SSDs (Dauwan et al., 2016). Although social support decreased at both time points, these attenuated values do not necessarily reflect a lack of social support: ratings remained, on average, in the "agree" range, indicating positive views of social support. Generally, the intervention was viewed as acceptable. Group attendance was 65%, Fitbit adherence was 81% during the intervention, and participants reported high satisfaction with the overall intervention and specific components (e.g., using the Fitbit device).

The study was limited by its small sample size, lack of a comparison condition, and relatively short duration. Moreover, many participants were not able to increase their exercise intensity to the recommended levels, which suggests that modifications to the intervention protocol should be made in the future (e.g., incorporating psychoeducational components addressing ways to increase exercise intensity). It is also important to interpret all effect sizes with caution, given that standardized change scores calculated using small samples may be subject to bias (Goulet-Pelletier & Cousineau, 2018). Considering objective physical activity only increased slightly during the active intervention and

Table 4. Client acceptability and feasibility.

	All participants ($n = 15$)
CSQ-8 total	28.40(3.44)
Client feedback	
A. How much did social interaction motivate you to attend groups?	3.67(0.98)
B. How much did walking different routes motivate you to attend groups?	2.73(1.22)
C. How much did health benefits motivate you to attend groups?	3.93(0.80)
D. How much did you like using a Fitbit?	4.07(1.22)
E. How likely are you to continue using Fitbit after study ends?	4.00(1.25)
F. How much did you like tracking your heart rate during walks?	3.67(1.35)
E. How much did you like the target heart rate goals?	3.00(1.13)
G. How much did you like setting weekly step goals?	3.33(1.23)
H. How much did you like setting goals for home-based walks?	3.13(1.19)
I. How much did you like receiving feedback on progress the previous week?	3.87(1.18)

Note: CSQ-8 – Client Satisfaction Questionnaire. Client feedback items were answered on a 1 – 5 scale. (1: Not at all, 2, 3: Somewhat, 4, 5: Very much). Higher scores reflect greater satisfaction.

was not maintained at follow-up, future interventions may benefit from an increased emphasis on strategies to create more sustained changes in exercise behavior. Future research should also consider examining the effects of PACE-Life in a randomized controlled trial with a comparison condition and over a longer time period, and with more stringent inclusion criteria regarding physical activity. Additionally, it may prove useful to identify those who may benefit most from this type of intervention in order to promote lasting improvements in health for individuals with SSDs.

Conclusions

The current study was an open trial of PACE-Life, a novel walking intervention aimed at increasing physical activity in individuals with SSDs. PACE-Life was viewed as acceptable and feasible, and resulted in improvements in key outcome measures including physical activity, sedentary behavior, and autonomous motivation. Even though substantive changes in CRF, physical health measures, social support, or quality of life were not observed in this open trial, the slight improvement/maintenance of these outcomes are encouraging. The findings of this study are preliminary and warrant cautious interpretation. Further examination of this intervention is also warranted. Additional research is needed to examine the effects of PACE-Life in comparison to a control condition, as well as to identify ways to maximize individuals with SSDs' long term participation in regular physical activities.

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