



Research Article

# Baseline Characteristics of Self-Determination Theory Constructs and Accelerometer-Derived Physical Activity: The Exercise Promotion in Primary Care (EPPC) Trial

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## Abstract

**Background:** Health behavior change theories provide a conceptual basis to promote physical activity, one of which is the Self-Determination Theory (SDT). This cross-sectional study compared SDT constructs, specifically exercise goal setting, exercise planning, and outcome expectations, with objectively assessed Moderate-To-Vigorous Physical Activity (MVPA) among a demographically diverse cohort of adults. **Methods:** Participants were 18 to 74 years with prediabetes or type 2 diabetes not prescribed insulin and were physically inactive by self-report. MVPA was assessed with accelerometers. Exercise goal setting, exercise planning, outcome expectancies, and demographics were obtained by survey. Linear regression models were used to assess the association between the SDT constructs and daily MVPA, adjusted for age, gender, race and ethnicity, education, and diabetes status. **Results:** The study included 451 participants, with a mean age of 53.2 years; 77% were women. Most (56%) reported Hispanic ethnicity, 20% were Black or African American, 18% white, and 7% other/unknown. On average, participants engaged in 24.5 (SD, 18.48) daily MPVA minutes. The cohort was most positive for exercise outcomes expectancies (mean 3.95 SD, 0.70) and least positive for exercise goal setting (mean 2.10, SD, 0.95). A 1-unit higher exercise goal setting score was associated with 3.05 (95% CI: 1.29, 4.81) more daily MVPA minutes. A 1-unit higher exercise planning score was associated with 3.16 (95% CI: -0.11, 6.33; p=0.05) more daily MVPA minutes. There were no substantive differences by gender, race, ethnicity, or education status. **Conclusions:** We found support for SDT constructs among adults with racial, ethnic, age, and educational diversity.

**Keywords:** Moderate-to-vigorous physical activity; Self-determination theory; Adults; Diabetes; Prediabetes; Cross-sectional study

**Abbreviations:** EHR: Electronic health record; MVPA: Moderate-to-vigorous physical activity; SDT: Self-Determination Theory

## Introduction

Regular physical activity is a recognized health behavior that reduces morbidity and premature mortality. The benefits for physical and mental health have been demonstrated in hundreds of publications over the last 70 years. Both the 2008 and 2018 US National Guidelines for Physical Activity recommend that most Americans should participate in regular physical activity [1,2].

Unfortunately, many Americans do not participate in sufficient physical activity to achieve important health benefits. To that end, a multitude of health behavior change theories have been applied to provide a theoretical basis for researchers and practitioners to promote physical activity to individuals. One of these theories that has gained attention is the Self-Determination Theory (SDT) [3].

SDT posits that motivation for a health behavior ranges on a continuum from external to internal components. The behaviors originating from one's self (i.e., autonomous or internalized) are thought to be more likely maintained compared with behaviors resulting from external forces. When a person becomes autonomously motivated toward a health behavior, they receive more effort, engagement, persistence, and are more likely to continue [3]. Randomized, controlled trials suggest that interventions based in SDT are promising for increasing PA [4,5].

The purpose of this study was to compare constructs of SDT with objectively assessed moderate-to-vigorous physical activity (MVPA) among a racially and ethnically diverse cohort of adults recruited into the Exercise Promotion in Primary Care (EPPC) trial. The analyses included cross-sectional baseline data collected prior to randomization. We explored if associations with objectively-assessed MVPA were consistent across demographic characteristics of age, gender, and educational status, as well as with people of different racial and ethnic identities. We were not aware of previous investigations that have tested these associations in diverse cohorts.

## Materials and Methods

EPPC was a randomized, controlled trial to determine the effects of a 2-year telephone-based motivational interviewing intervention on moderate-to-vigorous physical activity among adults with prediabetes or diabetes not requiring insulin. The study focused on patients who attended an outpatient clinic at a Kaiser Permanente Southern California (KPSC) Family Medicine

Department and were recruited using methods described below. The EPPC pilot was published [6]. Briefly, after completing baseline assessments, participants were randomized to a printed health education materials arm or motivational interviewing arm; follow-up assessments were conducted at 12 and 24 months.

## Participants

Potential participants included patients aged 18 to 74 years with a diagnosis of prediabetes, type 2 diabetes not prescribed insulin, or a blood glucose level indicating prediabetes; had a visit with their primary care provider in the prior 7 days; and were considered physically inactive (reported less than 30 minutes per week of moderate physical activity) based on the most recent Exercise Vital Sign [7,8] available in the electronic health record (EHR). Additional inclusion criteria included being able to speak and write English or Spanish, having a body mass index between 18.5 and 40 kg/m<sup>2</sup> recorded in the EHR, and able to participate in physical activity. Exclusion criteria included a cardiovascular event in the past 6 months, having undergone cancer treatment in the previous year, major psychiatric illness, currently breastfeeding, pregnant, or planning pregnancy, and not currently enrolled in weight loss or physical activity programs. Individuals with diabetes interested in participating were reviewed for eligibility by a physician prior to providing informed consent. The trial was approved by the Kaiser Permanente Southern California/Hawaii Institutional Review Board.

## Recruitment procedures

A program was written to identify potential participants based on inclusion and exclusion criteria and run against patient encounters and histories in the EHR weekly. From the generated list, brief emails were sent out to a maximum of 75 patients each week to introduce the trial, explain that there would be telephone outreach to determine interest, and an opportunity to opt out of further contact. Emails were sent in English or Spanish depending on the patient's preferred spoken and written language identified in the EHR. Bilingual and bicultural recruiters trained on study procedures contacted patients by telephone starting one week after emails were sent. After reaching a patient, recruiters described the trial, including measurement, randomization, each treatment arm, and follow-up expectations. If a patient was eligible after screening and remained interested, informed consent was obtained through REDCap (Research Electronic Data Capture), a secure, web-based-based software platform designed to support data capture for research studies. Participants were then mailed an accelerometer to wear for 7 consecutive days and emailed the link to an online survey to complete prior to randomization. In some instances, after obtaining consent a recruiter completed the survey with the participant over the telephone.

### Baseline Measurements

Physical activity was measured objectively with Actigraph® GT3X+ accelerometers. Participants were provided instructions on use and were asked to wear the monitor over their right hip for 7 consecutive days. Monitors were mailed via 1-day return receipt mail; after wearing the accelerometer, participants returned them in study-provided envelopes. The following count thresholds were used to assign each 60-second interval to a physical activity intensity category: sedentary (<100), light (100-1951), moderate (1952-5723), and vigorous (>5723 counts) [9]. Moderate to vigorous physical activity (MVPA) in minutes per week was calculated as the primary variable of interest.

Exercise goal setting and exercise planning are constructs of self-regulation consistent with the SDT [10], which was the theoretical underpinning of the intervention. These items were included in the baseline survey. The exercise goal setting scale consisted of 10 items with 5 response options (1-5) and internal consistency (Cronbach’s alpha) of 0.89 and 1-week test-retest of 0.87 [11]. Items include “I often set exercise goals,” and “my exercise goals help to increase by motivation for doing exercise.” The exercise planning and scheduling scale also consisted of 10 items and 5 response options. Internal consistency is 0.87 and 1-week test-retest was 0.89 [11]. Items include “I plan my weekly exercise schedule” and “I write my planned activity sessions in an appointment book or calendar.” Physical activity outcome expectancies is a 9-item scale with an internal consistency of  $\alpha=0.89$  [12]. In addition, two items from the outcomes expectancies scale that were highly relevant to SDT were evaluated separately; “Exercise is an activity that I enjoy doing,” and “Exercise gives me a sense of personal accomplishment.” For all the scales, a higher score indicated a more positive response.

Demographic information was obtained from self-report. This included gender (man, woman, other), age, employment status (full-time, part-time, self-employed, retired, unemployed; categorized as employed, retired, unemployed), current marital status (married, widowed, divorced, separated, never married, living with a partner; collapsed into married/partnered, living alone), highest level of education (high school or less, some college, college graduate or greater), and racial and ethnic identity.

### Analyses

Linear regression models were used to assess the association between each of the three SDT construct variables and daily MVPA minutes as a continuous measure, unadjusted and fully adjusted including the demographic variables age category, gender, race and ethnicity, educational status, and diabetes status. Educational and employment status were highly associated (Pearson’s Chi-squared: 14.81,  $p=0.005$ ) so analyses included only educational

status. Initial analyses examined potential collinearity across the SDT variables. Pearson’s correlation coefficients indicated collinearity (exercise goal setting by exercise planning  $R=0.49$ ;  $p<0.001$ ; exercise outcome expectancies by exercise goal setting  $R=0.30$ ;  $p<0.001$ ; exercise outcome expectancies by exercise planning  $R=0.15$ ;  $p=0.001$ ). Thus, models were run separately. Results are presented as the beta estimate for a 1-unit higher score in the SDT construct with 95% confidence intervals. Analyses were performed in R version 4.3.0.

### Results

EPPC randomized 451 participants into the trial, with a mean age of 53.2 years and among whom 77 percent identified as women (Table 1). Most participants (56%) were of Hispanic ethnicity, with 20% reporting to be Black or African American, 18% white, and 7% as other or unknown race or ethnicity. Almost three-quarters (72%) reported being employed, with 18% retired and 9.8% unemployed. A total of 69% were married or partnered. Participants were most likely to be classified with prediabetes (86%). On average, participants engaged in 24.5 (SD, 18.48) daily minutes of MVPA, based on accelerometry.

Characteristic	N=451
Age, yrs, mean (SD)	53.2 (11.34)
18-29 years (percent)	10 (2.2)
30-44 years	109 (24)
45-64 years	254 (56)
65 years and older	78 (17)
<b>Gender (percent)</b>	
Women	346 (77)
Men	105 (23)
<b>Race and ethnicity (percent)</b>	
Hispanic	251 (56)
Black	88 (20)
White	79 (18)
Other/Unknown	33 (7)
<b>Educational status (percent)</b>	
High school or less	155 (35)
Some college	169 (38)
College degree or higher	125 (28)
Unknown	2
<b>Employment status (percent)</b>	
Employed	322 (72)
Retired	83 (18)

Unemployed	44 (9.8)
Unknown	2
<b>Marital status (percent)</b>	
Married or partnered	312 (69)
Living alone	137 (31)
Unknown	2
<b>Diabetic Status (percent)</b>	
Prediabetes	386 (86)
Diabetes	65 (14)

Table 2 displays the mean values of the SDT constructs by demographic subgroup. Given that the three scores ranged from 1 to 5, the overall scores indicate the cohort was most positive for Exercise Outcomes Expectancies (mean 3.95 SD, 0.70) and lowest for Exercise Goal Setting (mean 2.10, SD, 0.95). There were no substantive differences by gender, race and ethnicity, or education status categories. The largest noted difference was for the exercise outcomes expectancy scores between the youngest (mean 3.51, SD 0.72) and oldest age groups (mean 4.03, SD 0.63).

**Table 1:** Baseline demographic characteristics and moderate-to-vigorous physical activity for participants in the Exercise Promotion in Primary Care (EPPC) trial.

	Social Determinant Theory Construct			MVPA (minutes/day) Mean (SD)
	Exercise Goal Setting Mean (SD)	Exercise Planning Mean (SD)	Exercise Outcomes Expectancies Mean (SD)	
Overall	2.10 (0.95)	2.35 (0.53)	3.95 (0.70)	24.5 (18.48)
<b>Age Category</b>				
18-29 yrs	1.80 (0.82)	2.30 (0.44)	3.51 (0.72)	22.2 (12.46)
30-34 yrs	2.06 (0.98)	2.37 (0.51)	3.97 (0.63)	26.9 (17.56)
45-64 yrs	2.14 (0.94)	2.34 (0.54)	3.94 (0.74)	25.8 (19.9)
65+ years	2.08 (0.96)	2.35 (0.55)	4.03 (0.63)	17.0 (12.94)
<b>Gender</b>				
Women	2.12 (0.97)	2.34 (0.55)	3.93 (0.73)	22.7 (16.91)
Men	2.05 (0.87)	2.38 (0.48)	4.02 (0.60)	30.3 (22.0)
<b>Race and ethnicity</b>				
Hispanic	2.20 (0.97)	2.40 (0.57)	3.98 (0.69)	26.7 (19.49)
Black	2.18 (0.88)	2.28 (0.45)	3.98 (0.59)	21.5 (16.88)
White	1.94 (0.98)	2.29 (0.47)	3.82 (0.79)	20.8 (17.13)
Other/unknown	1.58 (0.65)	2.21 (0.50)	4.00 (0.80)	24.2 (15.83)
<b>Education status</b>				
High school or less	2.10 (1.01)	2.32 (0.61)	3.92 (0.80)	25.8 (20.47)
Some college	2.07 (0.93)	2.32 (0.52)	3.93 (0.71)	24.8 (19.0)
College degree or higher	2.14 (0.89)	2.41 (0.41)	4.03 (0.54)	22.2 (14.68)
<b>Diabetes status</b>				
Prediabetes	2.10 (0.95)	2.35 (0.52)	3.92 (0.70)	25.3 (18.0)
Diabetes	2.11 (0.97)	2.32 (0.60)	4.13 (0.69)	19.5 (20.67)

**Table 2:** Social determinant theory constructs and daily minutes of moderate-to-vigorous physical activity by sex, age category, race and ethnicity category, educational, and diabetes status.

Results of the model indicated that higher exercise goal setting score was associated with higher MVPA. After full model adjustment, a 1-unit higher exercise goal setting score was associated with 3.05 (95% CI: 1.29, 4.81) more minutes of MVPA per day, or an additional 21 minutes per week (Table 3).

While the unadjusted model indicated a significant association between exercise planning score and MVPA, after adjustment there was no association ( $p=0.05$ ) (Table 3). The adjusted

model indicated that a 1-unit higher exercise planning score was associated with 3.16 (95% CI: -0.11, 6.33) more MVPA minutes per day.

There was no association between exercise outcome expectancies scale and moderate-to-vigorous physical activity (Table 3). The 2 individual items from the exercise outcomes expectations scale that were most closely aligned with the SDT were not associated with MVPA (Table 3).

Characteristic	Moderate to Vigorous Physical Activity			
	Unadjusted		Adjusted	
	Beta	95% CI	Beta	95% CI
Exercise goal setting	<b>3.11</b>	<b>1.32, 4.89</b>	<b>3.05</b>	<b>1.29, 4.81</b>
Exercise planning	<b>3.84</b>	<b>0.63, 7.04</b>	3.16	-0.01, 6.33
Exercise outcome expectancies	1.54	-0.91, 3.99	1.72	-0.68, 4.12
Exercise is an activity I enjoy doing	-1.05	-2.37, 0.27	-1.01	-2.31, 0.30
Exercise gives me a sense of personal accomplishment	0.84	-0.81, 2.49	0.52	-1.08, 2.12

**Table 3:** Association among exercise goal setting, exercise planning, and exercise outcome expectancies and moderate to vigorous physical activity, unadjusted and adjusted for race and ethnicity, gender, age category, educational status, and diabetes status. Models were individually analyzed.

Across all models there were no differences in associations between SDT constructs and MPVA by age category, gender, or educational status.

### Discussion

Among a diverse cohort of participants with prediabetes or diabetes not requiring insulin, we found some support for associations among SDT tenets and MVPA. Only higher scores for exercise goal setting, indicating a tendency to set goals, was significantly associated with greater daily MVPA. There was a non-significant trend for higher exercise planning scores to be associated with higher MVPA. No associations were noted for exercise outcome expectancies score.

Our results identified an association between higher goal setting scores, but not exercise planning scores, and higher MVPA although higher exercise planning score was associated with more physical activity prior to covariate adjustment. Resnick and colleagues reported that self-regulation skills, conceptualized as exercise goal setting and exercise planning, had a large effect on physical activity over an 8-week period [12]. Of note, Resnick et al.'s study consisted of college students, physical activity was obtained from self-report, and participants could have any amount of baseline physical activity. These differences between study designs may have been responsible for the present study's results. As the EPPC trial intervention arm encourages the use of self-regulatory skills, by the end of the trial, we will learn if SDT

constructs are associated with increased physical activity.

We are not aware of other investigations that have examined associations among physical activity and SDT constructs in adults with diverse races and ethnicities. Teixeira and colleagues conducted a systematic review of 66 studies evaluating physical activity and SDT [10]. They reported about 97% of the studies' participants were from Western cultures but did not provide details on race and ethnicity. In 2016 Miller and Gramzow published the rationale and design of a SDT-based trial for physical activity among a racially and ethnically diverse group [13]; results suggested that both SDT intervention and the physical activity-only comparison group increased their physical activity, assessed by self-report [14].

To be eligible to participate in EPPC, individuals had to have reported less than 30 minutes per week of MVPA, based on the EVS. Nonetheless, with accelerometry data, participants averaged 24.5 minutes of moderate-to-vigorous physical activity per day – a much higher count than assessed from self-report. There are notable differences between self-report and device-derived physical activity [15], in part because the latter includes activities that individuals do not consider to be exercise (e.g., walking in the house). Previous studies examining associations with SDT and physical activity have used self-report physical activity assessments. Self-report may be preferred for these types of studies as the SDT is of use for intentional physical activity rather than sporadic physical activity that is captured with devices.

The study has several limitations as well as strengths. The cohort was restricted to patients with diabetes or prediabetes who were enrolled in an integrated health plan in one region of Southern California. Further, the study required that at study entry they engaged in limited weekly physical activity. These limitations reduce the generalizability of the results. However, the cohort was large, with great racial, ethnic, age, and educational variability. Further, physical activity was assessed with accelerometry that provides a more complete assessment of physical activity than self-report, which often only captures planned exercise. Current national physical activity guidelines acknowledge that even small bouts of physical activity have health benefits.

### Conclusions

We found some support for SDT constructs at baseline assessments of a randomized clinical trial designed to increase MVPA among adults with prediabetes or diabetes without needing insulin. Given the intervention uses motivational interviewing to promote self-regulation skills, we are hopeful the assessed constructs change after intervention and are associated with increased physical activity among this cohort at increased cardiometabolic risk.

### Acknowledgements

We thank the study participants for their willingness to give their time to complete the study's assessments.

### Author Contributions

DRY designed the study with collaboration from MS, SPF, DC, JJ and AX. EF and JT collected the data, MW and MS performed the analysis, DRY drafted the manuscript and all authors made contributions to the contents by reviewing and revising the manuscript. All authors read and approved the final manuscript.

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### Data Availability

The datasets generated for the current study are not publicly available because there is the possibility that data could be traced back to individuals. Requests for the dataset should be addressed to the lead author (DRY) and will be reviewed on a case-by-case basis. Any sharing of data requires a data use agreement with Kaiser Permanente and the receiving institution.

### Declarations

### Ethics Approval and Consent to Participate

The trial was approved by the KPSC/H Institutional Review Board (IRB # 10106). Participants provided informed consent prior to data collection.

**Consent for Publication:** Not applicable.

### Competing Interests

The authors declare that they have no competing interests.

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