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Physical Activity Behavior Comparisons Between Adults With and Without Type 1 Diabetes

Cassandra M. Beattie
Kansas State University, cbeattie@ksu.edu

Jesse A. Stein
jesse.stein.2@gmail.com

Katie Heinrich
kansas state university, kmhphd@ksu.edu

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Abstract

Physical activity (PA) is a widely accepted strategy to manage chronic diseases like type 1 diabetes; however, unique PA barriers likely result in lower PA levels among person(s) with type 1 diabetes (PWT1D), compared to person(s) without type 1 diabetes (PWOT1D). The integrated theory of health behavior change (ITHBC) (i.e., knowledge/beliefs, self-regulation, and self-management) provides a helpful framework for understanding PA and other health behaviors. This research aimed to determine differences in PA between adult PWT1D and PWOT1D, and characterize their PA-related behaviors using the ITHBC. Participants (N = 90; 86.7% female, 90% white) were recruited via social media and university listserv to complete an online questionnaire. Questions addressed demographics, anthropometrics, diabetes status, and PA-related behaviors. Participants were matched for race, gender, age, and body mass index. PA and related behaviors were compared between PWT1D and PWOT1D using independent samples t-tests and chi-square-tests. No significant differences were found between PWT1D and PWOT1D for weekly minutes of moderate- or vigorous-aerobic PA, or weekly days of muscle-strengthening PA ($p > 0.05$). Fifty-one percent of PWT1D and 53.3% of PWOT1D reported enough activity to meet PA guidelines. Almost twice as many PWT1D meeting PA guidelines reported using goal setting, a self-regulation behavior, compared to those who did not meet guidelines (82.6% versus 45.5%, $p = 0.009$). Targeting PA-related behaviors within ITHBC constructs may help reinforce or influence PA behaviors. These findings can inform future behavior change interventions with PWT1D that focus on educational practices for type 1 diabetes educators or healthcare providers for PWT1D so they can better aid patients.

Keywords

physical activity behaviors, exercise behaviors, diabetes

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Cassandra M. Beattie, CPT, MS*
Jesse A. Stein, Med, PhD
Katie M. Heinrich, PhD, FAAHB, FACSM

Abstract

Physical activity (PA) is a widely accepted strategy to manage chronic diseases like type 1 diabetes; however, unique PA barriers likely result in lower PA levels among person(s) with type 1 diabetes (PWT1D), compared to person(s) without type 1 diabetes (PWOT1D). The integrated theory of health behavior change (ITHBC) (i.e., knowledge/beliefs, self-regulation, and self-management) provides a helpful framework for understanding PA and other health behaviors. This research aimed to determine differences in PA between adult PWT1D and PWOT1D, and characterize their PA-related behaviors using the ITHBC. Participants ($N = 90$; 86.7% female, 90% white) were recruited via social media and university listserv to complete an online questionnaire. Questions addressed demographics, anthropometrics, diabetes status, and PA-related behaviors. Participants were matched for race, gender, age, and body mass index. PA and related behaviors were compared between PWT1D and PWOT1D using independent samples t-tests and chi-square-tests. No significant differences were found between PWT1D and PWOT1D for weekly minutes of moderate- or vigorous-aerobic PA, or weekly days of muscle-strengthening PA ($p > 0.05$). Fifty-one percent of PWT1D and 53.3% of PWOT1D reported enough activity to meet PA guidelines. Almost twice as many PWT1D meeting PA guidelines reported using goal setting, a self-regulation behavior, compared to those who did not meet guidelines (82.6% versus 45.5%, $p = 0.009$). Targeting PA-related behaviors within ITHBC constructs may help reinforce or influence PA behaviors. These findings can inform future behavior change interventions with PWT1D that focus on educational practices for type 1 diabetes educators or healthcare providers for PWT1D so they can better aid patients.

*Corresponding author can be reached at: cbeattie@ksu.edu

Introduction

Over 200,000 Americans are estimated to have type 1 diabetes (T1D) (American Diabetes Association [ADA], 2020b). T1D – an autoimmune disease that destroys insulin-producing beta cells – is a metabolic disease that leads to complete insulin deficiency (ADA, 2020a). To enhance glycemic control and temporarily restore metabolic function, person(s) with T1D (PWT1D) are prescribed exogenous insulin (ADA, 2020a). Physical activity (PA) also improves chronic glycemic control (i.e., hemoglobin A1C) and decreases insulin requirements in PWT1D (Chimen et al., 2012; Tagougui et al., 2019). It is recommended that PWT1D adopt a physically active lifestyle (Matson et al., 2018).

The current PA guidelines for Americans recommend adults participate in at least 150 minutes of moderate-intensity aerobic PA, 75 minutes of vigorous-intensity aerobic PA, or a combination of both per week, in addition to full-body muscle-strengthening PA two times weekly (United States Department of Health and Human Services [USDHHS], 2018). For adults with chronic health

conditions, such as PWT1D and type 2 diabetes, recommendations are the same, although they should be under the care of a health provider (USDHHS, 2018).

T1D differs from other chronic health conditions due to etiological differences (ADA, 2020a). Lifestyle behaviors can drive many chronic health conditions, whereas T1D results from autoimmune cells attacking beta cells from an unknown stimulus (ADA, 2020a; Willett et al., 2006). This generates the need for unique PA recommendations for PWT1D that consider the etiology, symptoms, and range of their condition. Despite reported benefits of PA for T1D management, leaders in diabetes and sports medicine have been unable to provide specific recommendations for optimal types of PA for adult PWT1D (ADA, 2020a; Colberg et al., 2016; PAGAC, 2018). These leaders highlighted a lack of critical information regarding the optimal frequency, duration, intensity, and type of PA necessary to make appropriate recommendations (ADA, 2020a, USDHHS, 2018).

Although PA recommendations are scarce, adult PWT1D report similar but fewer weekly PA minutes than person(s) without T1D (PWOT1D) (Colberg, 2017; Matson et al., 2018; Zhao et al., 2008). Decreased PA levels among PWT1D may largely be due to two unique PA barriers including a lack of disease-specific PA recommendations and fear of hypoglycemia (i.e., low blood glucose) (ADA, 2020a; Colberg et al., 2016; PAGAC, 2018; Yardley & Sigal, 2015). Hypoglycemic fears may impede PA levels and cause PWT1D to overeat carbohydrates or reduce insulin doses prior to PA to offset blood glucose fluctuations (Yardley & Sigal, 2015). These compensatory behaviors may result in increased fat mass, deteriorate glycemic control, and reverse the benefits of PA and exercise (i.e., PA that is planned, structured, and repetitive; Yardley & Sigal, 2015).

Additionally, health care providers lack thorough resources to educate adult PWT1D about PA to promote disease management (Knight et al., 2016). However, understanding the relationship between PA-related behaviors and PA levels (i.e., doing enough weekly PA to meet the guidelines) may provide an insightful solution for these barriers and educational needs. PA-related behaviors such as goal setting, self-regulation, pre-exercise strategies, post-exercise strategies, and actively trying to learn more about PA may influence PA levels (Fredriksson et al., 2018; Ryan, 2009). The integrated theory of health behavior change (ITHBC; Ryan, 2009) provides a means to characterize these PA-related behaviors.

By using a theoretical framework, the nature of PA-related behaviors and PA levels among PWT1D can be elucidated. Figure 1 was adapted from Ryan (2009) and represents the ITHBC framework (Ryan, 2009). The engagement in self-management behaviors is the proximal outcome influencing the distal outcome of improved health status (Figure 1). Therefore, health behaviors, such as PA participation, can be improved through a person's knowledge and beliefs (factual information, personal perceptions), self-regulation skill and ability (goal setting, self-monitoring and reflective thinking, decision making, planning and plan enactment, self-evaluation, and management of emotions), and social facilitation (social influence and social support), by ultimately enhancing their engagement in self-management behaviors (Ryan, 2009). Knowledge and health beliefs have the power to influence engagement in self-regulation behaviors, while self-regulation skills and abilities have the power to influence self-management behaviors (Ryan, 2009). Positive influences via social facilitation also improve participation in self-regulation and self-management behaviors such as PA that ultimately improve health status (Ryan,

2009). Based on the framework, possessing enough PA-related behaviors should influence engagement in self-management behaviors and ultimately influence PA levels and therefore improve one's health status (Ryan, 2009).

To date, limited studies have examined PA levels between adult PWT1D and PWOT1D, with no research reporting PA-related behaviors among PWT1D (Aljawarneh et al., 2019; Lascar et al., 2014; Matson et al., 2018; Valerio et al., 2007). In combination, knowledge and beliefs related to PA, self-regulatory skills and abilities related to PA, and how social facilitation may influence PA are considered PA-related behaviors. An examination of PA-related behaviors can help identify key factors related to PA levels among adult PWT1D. Identifying the etiology of differing PA levels among adult PWT1D may aid healthcare providers in optimizing treatment options and improving patient-centered outcomes. Thus, our study compared PA levels between adult PWT1D and PWOT1D, and examined PA-related behaviors for each group using the ITHBC framework (Ryan, 2009). We hypothesized that PWT1D would report significantly less PA than adult PWOT1D, and that participants meeting PA guidelines would report more PA-related behaviors than those not meeting guidelines.

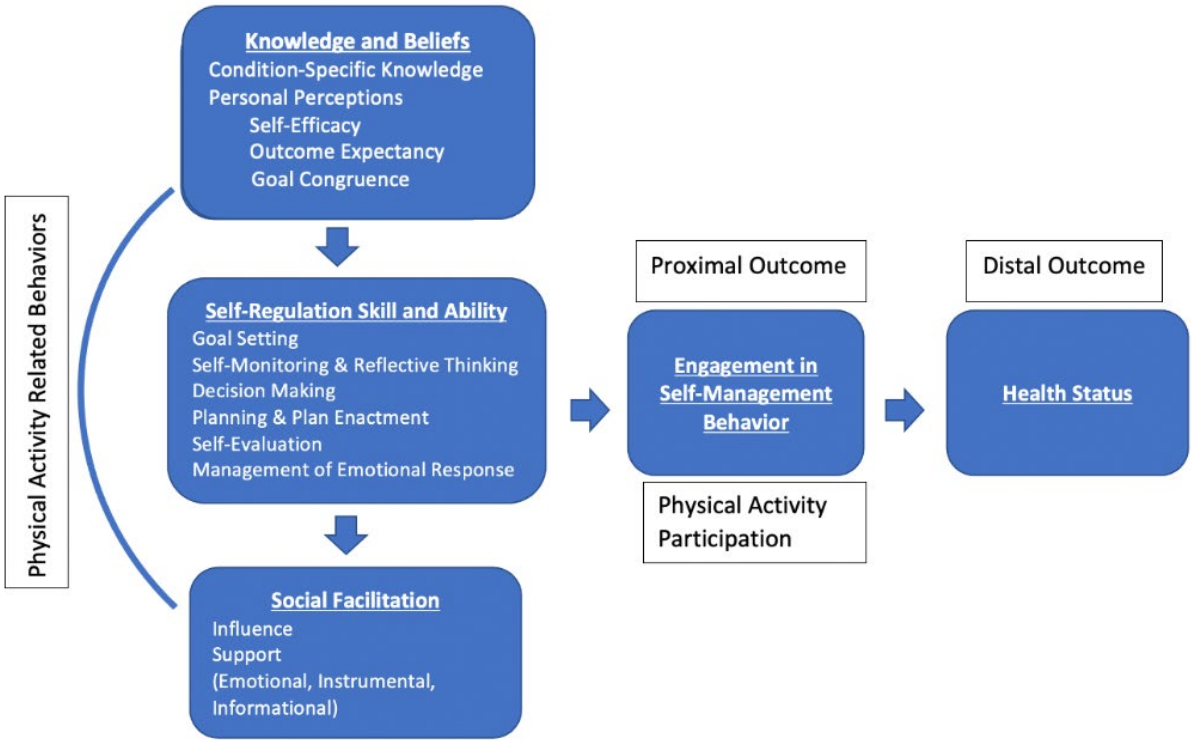

Figure 1. The Integrated Theory of Health Behavior Change

Methods

Design and Participants

A cross-sectional online survey questionnaire was employed to discern PA behaviors in adult PWT1D and PWOT1D. Study inclusion criteria included being 18-64 years old, English literate, and able to complete PA or exercise. Participants having a physical or mental condition prohibiting PA participation were excluded. Fifty adult PWT1D responded to the online questionnaire; five incomplete responses were removed from analysis. The final sample of PWT1Ds (n = 45) and PWOT1D controls (n = 45) were matched by race, age, gender, and by ± 2 body mass index (BMI; kg/m2).

Questionnaire and Measures

Participants were classified as PWT1D if they were diagnosed at least 6 months prior to completing the questionnaire. The questionnaire then branched, so that PWOT1D completed one branch that included 36 questions and PWT1D participants completed the other branch with 50 questions. Participants indicated their gender, age, race, and ethnicity. Validated self-report questionnaire measures have been created to identify perceived PA barriers (e.g., Barriers to Physical Activity in Type 1 Diabetes scale; BAPAD-; Diabetes Attitude Scale) for those with diabetes, but no validated questionnaires exist for assessing interpersonal influences that affect PA-related behaviors of PWT1D, making our

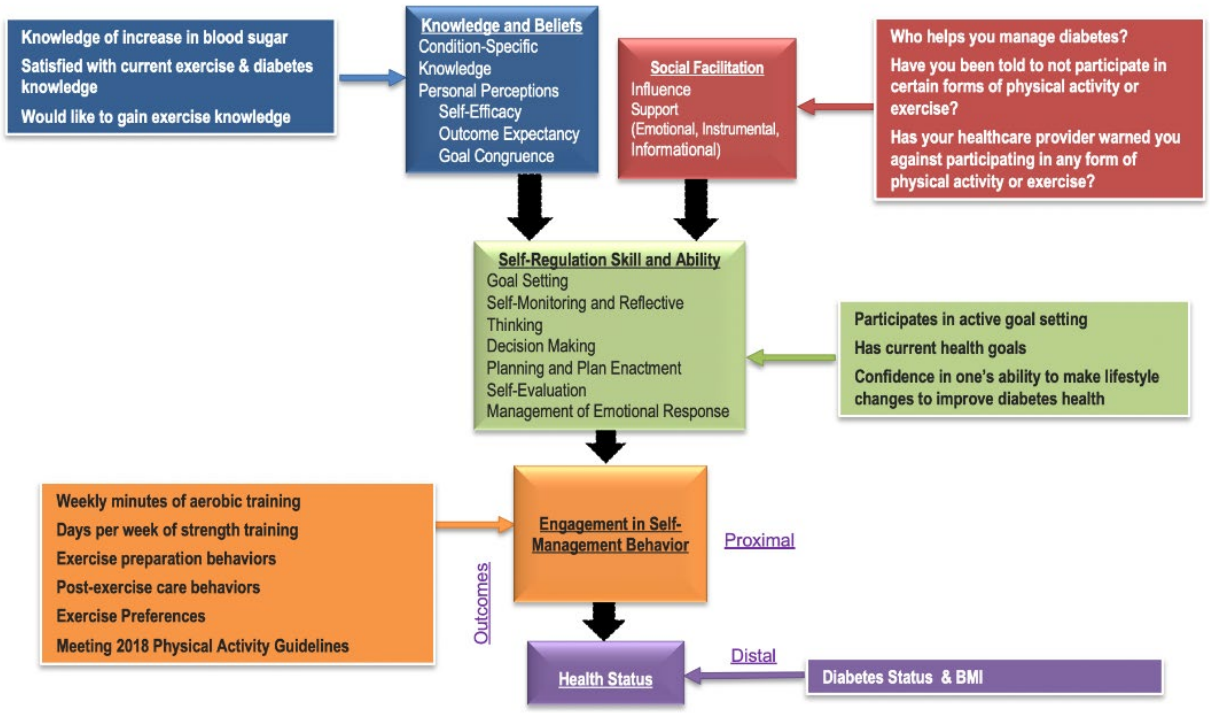

Figure 2. Questionnaire Measures within the ITHBC Framework

questionnaire unique (Anderson et al., 1998; Brazeau et al., 2012). Figure 2 below was adapted and modified from Heinrich et al. (2017) and details how the remaining questionnaire measures utilized the ITHBC framework.

Knowledge and beliefs. PWT1D were asked if they knew when their blood glucose was too high ('yes'/'no'). They were also asked, "How satisfied are you with your supplied education on diabetes?", on a 7-point Likert scale ranging from '1-extremely satisfied' to '7-extremely dissatisfied.' These questions were reverse-scored for analysis for PWT1D. Both questionnaire branches addressed the desire to increase knowledge and beliefs by asking participants to explain, "What would you like to learn about exercise and PA in relation to your health?" Similar answers were grouped into common themes. Responses to these questions were used to analyze whether relationships existed between PA levels and the PA-related behavior of wanting to learn more about exercise and PA.

Engagement in self-management behavior. All participants were asked what they did to prepare to participate in PA or exercise. Inventory items were modified from the Department of Defense health-related behaviors questionnaire (Meadows et al., 2018) and participants were asked to report the number of days in the past 30 that they did moderate, vigorous, and muscle-strengthening PA ('not at all in the past 30 days' to 'about every day'). Participants also reported the average minutes per day they typically did moderate-intensity and vigorous-intensity physical activities. Exercise preferences were identified with two questions: 1) Which do you prefer more: resistance training, aerobic training, both equally, other (specify)?; and 2) Please explain your preference for the type of activity you chose. Lastly, PWT1D were asked to explain what they did after PA or exercise to take care of/control their diabetes/self (i.e., take supplements, drink water, other including description, etc.). Exercise preferences were examined for the most commonly reported amongst PWT1Ds and PWOT1Ds. Similar responses for exercise preparation and post-exercise care were simplified into common themes.

Self-regulation skill & ability. All participants were asked, "Do you actively engage in goal setting for your health?" ('yes'/'no'). If 'yes', they were asked to explain their current health-related goals. Additionally, PWT1D reported their confidence in their ability to learn about diabetes and make lifestyle changes in order to improve their health (not at all/somewhat/very). Responses were analyzed to compare PA levels of those who engaged in goal setting and/or reported self-confidence and those who did not, for PWT1D and PWOT1D.

Social facilitation. PWT1D were asked who helped them manage their diabetes using modified inventory items from the Behavioral Risk Factor Surveillance System (BRFSS; Centers for Disease Control and Prevention [CDC], 2018). Participants selected all that applied out of no-one, family, co-workers, health-care providers, support groups, and other (specify). Responses were used to identify social support status for data analysis. Additionally, both questionnaire branches asked if a health care provider or anyone else had told them to not participate in certain kinds of PA or exercise ('yes'/'no'). Participants who answered 'yes' were asked to explain the kind of PA or exercise they had been warned against.

Health status. Participants were asked their diabetes status and pre-diabetes status. Diabetes status was measured as either PWT1D or PWOT1D. If participants answered that they were PWOT1D, they were then provided a follow-up question regarding whether they had or had not been

previously diagnosed with pre-diabetes. Height and weight were also asked of participants to classify BMI status (i.e., < 18.5 kg/m^2 = underweight, 18.5-24.9 kg/m^2 = normal weight, 25-29.9 kg/m^2 = overweight, and 30+ kg/m^2 = obese; CDC, 2020).

Procedures

Following IRB approval (#9743), the questionnaire was open for 8 weeks. The questionnaire was advertised via university e-newsletter to all students, faculty, and staff on the day the questionnaire opened (May 14, 2019), and continued to be advertised on social media until July 8, 2019. Facebook posts were created and shared within the local community, in a nearby major metropolitan area, and on general diabetic Facebook pages. Questionnaire information was also disseminated via Instagram through shared stories and messages, as well as on Twitter via Tweets. All participants accessed the questionnaire online via a single link through bitly (http://bit.ly/t1dmt2dm).

Participants filled out an eligibility screening form, followed by informed consent via Qualtrics (Qualtrics Labs Inc., Provo, UT, USA). A complete questionnaire is available (Beattie, 2019). After questionnaire completion, participants were redirected to a separate questionnaire where they could enter their email for a chance to win one of eight gift cards of up to a $75 value.

Data Analysis

A mixed methods analysis was conducted. Open coding was used to organize qualitative responses to questionnaire items into themes (Auerbach & Silverstein, 2003). Based on previous research examining differences in self-reported PA by diabetes status, 33 participants/group (N = 66 for both groups) were needed to have 80% power and 43 participants/group (N = 86 for both groups) for 90% power (Chow et al., 2003; Fleiss et al., 2003; D'Agostino et al., 1988; Machin et al., 1997). PA levels were reported as average minutes per week of moderate- and vigorous-intensity aerobic activity (calculated by daily frequency of PA multiplied by average duration in minutes) and average days per week of muscle-strengthening PA. These calculations were used to determine whether participants met PA guidelines (USDHHS, 2018).

Descriptive analyses were completed using SPSS version 25 (IBM; Armonk, NY), including sample means, standard deviations, and frequencies for comparisons between groups for questions within the ITHBC framework. For hypotheses testing, independent t-tests with Levene's test for equality of variances were used to determine differences between groups for self-reported PA reported in weekly minutes per week of aerobic activity (moderate- and vigorous-intensity) and days per week of muscle-strengthening PA. A chi-square analysis was used to determine the relationship between PA levels and PA-related behaviors for PWT1D and PWOT1D. A Fisher's exact test was used to when expected counts were less than 5.

Results

There were 615 total clicks on the questionnaire link. Of those, 456 individuals initiated the screening questions. Thirty-seven were ineligible based on age (n = 12), inability to do PA or exercise due to a mental or physical condition (n = 22), not completing the screening questions (n = 2), or not agreeing to participate in the questionnaire (n = 1). The remaining 419 consented to the questionnaire. Ten participants who answered no questionnaire questions were excluded from the analyses, along with one participant who solely provided demographic information, five

participants who did not specify their type of diabetes, and those with incomplete questionnaire data (n = 69), leaving a total of 334 valid responses for matching. As stated previously, 45 PWT1D were matched with 45 PWOT1D, for a total sample of 90 respondents (14.6% response rate).

Groups had similar demographic characteristics due to matching procedures. Participants were predominately white (90.0%, n = 81) women (86.7%, n = 78). Few participants were black (4.4%), 2.2% were Asian, 3.3% were mixed race, 1.1% identified as other, and 4.4% identified as being Hispanic or Latino. The mean age of PWT1D participants was 27.7 ± 10.1 years and PWOT1D was 27.9 ± 9.9 years.

Comparison of PA Levels Between PWT1D and PWOT1D

Overall, 51.1% of PWT1D (n = 23) and 53.3% of PWOT1D (n = 24) met the 2018 PA guidelines, and all participants reported at least some weekly minutes of PA (range = 1,601 aerobic minutes per week). No significant differences were found for average weekly minutes (min) of moderate-intensity aerobic PA between PWT1D (285.2 ± 225.0 min) and PWOT1D (331.8 ± 305.7 min), $t(88) = -0.824$, $p = 0.412$. No significant differences were found for average weekly min of vigorous-intensity aerobic PA between PWT1D (120.4 ± 113.3 min) and PWOT1D (108.0 ± 106.5 min), $t(88) = 0.535$, $p = 0.594$. No significant differences were found for weekly days of muscle-strengthening PA between PWT1D (1.9 ± 2.0 days) and PWOT1D (1.7 ± 1.6 days), $t(88) = 0.471$, $p = 0.639$.

PA Level and PA-related Behaviors

Participant PA levels and PA-related behaviors are shown in Table 1. Complete data were available for 71 PWT1D and PWOT1D (78.9%) regarding PA knowledge, 12 PWT1D (26.7%) regarding social support, and 54 PWT1D and PWOT1D participants (60.0%) regarding goal setting. A chi-square analysis revealed a significant relationship between goal setting and meeting PA guidelines for PWT1D [$X^2(1) = 6.8$, $p = 0.009$]. Fisher's exact tests revealed no significant relationship between meeting PA guidelines and PA knowledge for PWT1D ($p = 0.24$) and PWOT1D ($p = 0.78$), and/or social support for PWT1D ($p = 0.17$).

Engagement in Self-management Behavior

Over 95% of PWT1D (n = 43) and 93.3% of PWOT1D (n = 42) reported participating in exercise preparation behaviors. Over 97% of PWT1D (n = 44) and all PWOT1D (n = 45) reported having post-exercise care behaviors. Over 50% of PWT1D (n = 23; 50.1%) and PWOT1D (n = 24; 53.3%) met the 2018 PA guidelines for weekly total aerobic PA minutes and days of muscle-strengthening PA. Themes of reported pre- and post-exercise care behaviors included nutrition and relaxation techniques. PWT1D commonly reported checking their blood sugar before and after exercise and supplementing as needed to keep their blood sugars in a healthy range. Additionally, participants reported their exercise preferences, with walking, resistance training (weightlifting and strength training), and running reported as the most common. Note that participants could list more than one preferred type. Exercise preferences reported are shown in Table 2.

Table 1

Relationship Between PA Levels and PA Behaviors for Both Groups Combined

Characteristic	Person(s) With Type 1 Diabetes *N* (%)		Person(s) Without Type 1 Diabetes *N* (%)	
	Yes	No	Yes	No
Did not meet 2018 Physical Activity Guidelines				
Wanted more physical activity knowledge	15 (83.3)	3 (16.7)	18 (85.7)	3 (14.3)
Reported social support	17 (81.0)	4 (19.0)	--	--
Reported goal setting	10 (45.5)	12 (54.5)	9 (42.9)	12 (57.1)
Met 2018 Physical Activity Guidelines				
Wanted more physical activity knowledge	19 (95.0)	1 (5.0)	19 (82.6)	4 (17.4)
Reported social support	30 (71.4)	12 (28.6)	--	--
Reported goal setting	19 (82.6)	4 (17.4)	25 (55.6)	20 (44.4)

Table 2

Person(s) with Type 1 Diabetes vs. Persons without Type 1 Diabetes Exercise Preferences

Preferred Exercise Type	Person(s) With Type 1 Diabetes (*N*)	Person(s) Without Type 1 Diabetes (*N*)
Walking	29	41
Running	18	22
Resistance/Strength Training	18	21
Biking	8	16
Recreational Sports	8	7
Cardio	8	5
Hiking	5	2
High-Intensity Interval Training	4	3
Yoga	3	7
Stair Climbing	3	5
CrossFit	3	1
Gardening/Yard Work	2	7
Dancing	2	2
Horseback Riding	2	2
Group Fitness Classes	2	2
Climbing	2	1
Rowing	2	1
Boxing	2	0
Barre	1	2
Pilates	0	2

Knowledge & Beliefs

Thirty-seven PWT1Ds (82.2%) reported being knowledgeable of an increase in blood glucose. Over 40% of PWT1D (n = 22) felt moderately or extremely satisfied with their exercise knowledge. The majority of participants in each group (PWT1D = 75.6%, n = 34; PWOT1D = 82.2%, n = 37) wanted to gain further exercise knowledge on items such as effects on blood glucose, how to affordably work out, and specific guidelines and/or recommendations for exercise. A further breakdown of the results is shown below in Table 3.

Self-regulation Skill & Ability

While 29 PWT1D (64.4%) reported participating in active goal setting for health, slightly fewer PWOT1D did (n = 25, 55.6%). The same numbers were reported for participants indicating having current health goals. Current health goals reported for PWT1D included improving A1C numbers, better blood glucose control, increased exercise participation, improved nutrition, and weight loss (data not shown). PWOT1D participants reported health goals such as improved nutrition, improved exercise participation, improved body composition, weight loss, increased strength, participation in new fitness challenges, and improved quality of life. Over half of PWT1D (59.2%, n = 28) felt very confident in their ability to make lifestyle changes to improve their diabetes health, while merely 31.1% (n = 14) felt somewhat confident.

Social Facilitation

PWT1D mostly received help for managing their diabetes from family members (40.0%, n = 18) or health care providers (40.0%, n = 18), with others reporting help from no one (31.1%, n = 14), co-workers (6.7%, n = 3), a support group (6.7%, n = 3), and other (22.2%, n = 10). In general, 15.6% of PWT1D (n = 7) and 8.9% of PWOT1D (n = 4) reported being told to not participate in certain forms of PA or exercise, while one PWT1D and two PWOT1D reported that their health care provider warned them against certain kinds of PA or exercise. Table 4 provides seven example responses detailing the types of activities participants were cautioned against.

Health Status

Over 4% of PWOT1D (n = 2) were pre-diabetic. Average BMIs were in the overweight range for both PWT1D (26.3 ± 5.1 kg/m^2) and PWOT1D (25.0 ± 3.5 kg/m^2).

Discussion

This study compared PA levels between adult PWT1D and PWOT1D and examined PA-related behaviors for both groups using the ITHBC framework (Ryan, 2009). We hypothesized that adult PWT1D would report significantly less PA than adult PWOT1D, and that participants meeting PA guidelines would report more PA-related behaviors. We found no significant differences in PA levels between PWT1D and PWOT1D. Both groups reported similar weekly minutes of moderate- and vigorous-intensity aerobic PA and days of muscle-strengthening PA. In partial support for the second hypothesis, adults who met PA guidelines were more likely to report PA-related goal-setting behaviors.

Our results differ from previous research where adult PWT1D reported less weekly PA than adult PWOT1D (Colberg, 2017; Matson et al., 2018; Zhao et al., 2008). The difference for our findings may be due to our recruitment via fitness influencers on social media, or possibly the PA focus of the questionnaire. Both study groups were rela-

Table 3

Knowledge and Belief Questionnaire Frequencies

Characteristic	Person(s) With Type 1 Diabetes N (%)	Person(s) Without Type 1 Diabetes N (%)
Knowledge of increase in blood glucose	37 (82.2)	--
Satisfied with current exercise & diabetes knowledge:		
Extremely satisfied	5 (11.5)	--
Moderately satisfied	17 (37.8)	--
Slightly satisfied	6 (13.3)	--
Neither satisfied nor dissatisfied	7 (15.6)	--
Slightly dissatisfied	5 (11.1)	--
Moderately dissatisfied	1 (2.2)	--
Extremely dissatisfied	1 (2.2)	--
Would like to gain exercise knowledge	34 (75.6)	37 (82.2)

Table 4

Example Participant Responses Regarding Warnings against Certain Types of Physical Activity or Exercise.

Categories/Themes	Person(s) With Type 1 Diabetes Response	Person(s) Without Type 1 Diabetes Response
Q: Please list who and what forms of activity you were told not to participate in?	Coaches and people lacking the knowledge on how to handle a diabetic on a team involved in physical activity. More of a safety concern since they don't know what to do if something was to go wrong.	No running/jumping due to knee replacement.
		No heavy weights due to hernia.
		Activities that can cause knee problems
	People in the dorms, and pretty much any and every form because they don't know anything about diabetes and they get scared.	Intense running or biking due to injury
	I was told I could never make it through Fire School and I did.	

tively similar in their PA reported, including exercise preferences. Walking was the most common form of PA and exercise by both groups; followed by both resistance training and running, which agrees with previous research that found walking to be the most frequent form of PA for U.S. men and women (Dai et al., 2015).

Our study revealed no significant differences for those meeting or not meeting PA guidelines for desiring PA knowledge and/or receiving social support. It is unclear whether our participants were offered but did not utilize social support or whether they had access to social support in the first place. Previous research utilizing the ITHBC found that women working on weight management failed to utilize social support resources (Ryan et al., 2011). Social support, along with knowledge, are useful for behavior change (Ryan et al., 2011). Yet for some of our participants, attaining further exercise knowledge did not seem easy. Previous research has identified the need for education about the effects of exercise on T1D control and its complications (Lascar et al., 2014). However, even healthcare providers report little to no formal training on PA and exercise for PWT1D, thereby limiting their scope of practice (Knight et al., 2016).

We did find that participants meeting PA guidelines were significantly more likely to practice goal setting. Goal setting, within the ITHBC, is an effective self-regulation skill that elicits behavior change (Ryan et al., 2011). For example, older adults utilizing goal setting reported long-term improvements in PA (Hobbs et al., 2013). Practicing healthy behaviors such as PA to address PWT1D goals (better blood glucose control, A1C numbers, weight-management, and exercise participation) has the potential to improve health and reduce secondary symptoms of diabetes (PAGAC, 2018).

Sufficient statistical power, the ability to match PWT1D and PWOT1D, and a thorough examination of PA-related behavioral factors linked to key behavioral constructs of the ITHBC are all strengths of our study. To our knowledge, this is the first study to directly examine the prevalence of adult PWT1D meeting the 2018 PA guidelines compared to adult PWOT1D counterparts. Many of our questionnaire items were formulated specifically for PWT1D and were reviewed by a variety of individuals (n = 10) with subject matter expertise including: a PWT1D, an endocrinologist, nurses from diabetes clinics, university students, and individuals without diabetes to help ensure question readability and understanding.

Study limitations include potential self-selection bias, where people engaging in PA and exercise behaviors may have been more likely to respond to the questionnaire, limiting generalizability of results. Participants were asked to report their PA over the last 30 days as opposed to the last 7 days. Since the current PA guidelines for Americans are for weekly physical activity participation, this may have created the potential for misclassifying whether or not the participant met PA recommendations. Increases in response rates for PWT1D seemed to follow social media posts on Instagram via pages used for tracking weight-loss from PA, exercise, and diet. Some people that were personally asked to participate in the questionnaire refused because they felt their complete lack of PA would not be helpful. Future research could focus on recruiting participants outside of social media that may not already be on a fitness, weight-loss, or fitness induced weight-loss journey, in order to get more representative responses. Additional questions pertaining to specific characteristics (such as number of years since diabetes diagnoses) could be used to better categorize participants in the future to conduct additional analyses to further

differentiate differences in PA and related behaviors over time. Additional questions could also be asked about other aspects of self-regulation (e.g., reflective thinking, management of emotions) and skills to solicit social support. Longitudinal data gathered over different times of the year may also provide a better understanding of influences on environmental conditions for PA behaviors.

Implications for Health Behavior Theory

Our data can be used to inform future behavior change interventions with PWT1D for researchers and practitioners alike. Despite half of participants meeting PA recommendations, 75-80% of both groups wanted more knowledge related to PA and exercise. By addressing aspects of the ITHBC through targeting PA-related behaviors within its constructs, it is possible to influence and reinforce behavior change, and ultimately, improve the health of PWT1D (Ryan, 2009; Ryan et al., 2011). Future research should delve into the types of goals PWT1D set (e.g., short-term, long-term, extrinsic, intrinsic) and discern those best for behavior change. Future PA interventions could potentially be conducted combining both PWOT1D and PWT1D adults to see the effectiveness of the two populations' social facilitation of one another. Additional research should improve educational practices for T1D educators or healthcare providers for PWT1D to better support their patients. By acquiring further knowledge on PA and exercise, PWT1D could possibly become more active and increase the number meeting both portions of the PA guidelines.

Discussion Questions:

1. What are some variables that should be accounted for in future studies?
2. Self-taught exercise knowledge among PWT1D creates the question as to how PWT1D are to further their exercise knowledge if healthcare providers are not equipped with answers?

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