Youth and parent perspectives on the acceptability of a group physical activity and coping intervention for adolescents with type 1 diabetes

Melissa DeJonckheere^{1,2}

Kevin Joiner^{2,3}

Garrett I. Ash^{4,5}

Mary Savoye⁶

Mackenzie Adams³

Stuart A. Weinzimmer⁶

Lois S. Sadler⁷

Margaret Grey⁷

¹Department of Family Medicine, Medical School, University of Michigan

²Institute for Healthcare Policy and Innovation, University of Michigan

³School of Nursing, University of Michigan

⁴Veterans Affairs Connecticut Healthcare System

⁵Center for Medical Informatics, Yale University

⁶Department of Pediatric Endocrinology, Yale University

⁷School of Nursing, Yale University

Correspondence:

Melissa DeJonckheere, PhD

1018 Fuller St.

Ann Arbor, MI 48104

mdejonck@med.umich.edu

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Abstract

Introduction: To maintain optimal glycemic levels and prevent long-term complications, adolescents with type 1 diabetes (T1DM) should engage in regular moderate to vigorous activity (MVPA) in addition to other diabetes self-care behaviors. Though interventions to prepare adolescents safely increase MVPA have been developed and tested, barriers continue to limit dissemination and engagement in clinical and community settings.

Objective: To examine youth and parent perspectives on the acceptability of a group physical activity and coping intervention for adolescents with T1DM.

Subjects: 18 adolescents (11-19 years) with T1DM who completed the intervention and at least one of their parents.

Methods: Adolescents completed an exit survey measuring satisfaction with the intervention (program components, comfort, and instructors) on a 5-point scale. Semi-structured interviews were conducted with adolescents and at least one parent. Qualitative description was used to develop themes that summarize participant experiences during the intervention.

Results: The intervention was rated highly: program components ($M=4.5$), comfort ($M=4.4$), and instructors ($M=4.3$). Themes included: (1) Adolescents and parents valued being around others with T1DM and their families; (2) The intervention helped adolescents gain knowledge and reinforce diabetes self-management behaviors; (3) Challenges included convenience and sustaining participant engagement; and (4) Adolescents intended to sustain physical activity and diabetes self-management behaviors after the intervention.

Conclusions: Adolescents with T1DM and their parents viewed a group physical activity and discussion intervention as a positive experience. Because participants highly valued the group aspect of the intervention, future MVPA interventions would likely benefit from integrating social interactions with others with T1DM.

Keywords: adolescent health; type 1 diabetes; diabetes intervention; physical activity; youth health behaviors

Introduction

Achieving glycemic targets during childhood and adolescence has major implications for type 1 diabetes (T1DM) outcomes and quality of life, yet about 80% of adolescents with T1DM have glycosylated hemoglobin (A1C) levels that are higher than the American Diabetes Association recommended target of <7.0% (53 mmol/mol).¹ To maintain optimal glucose levels and prevent long-term complications, it is recommended that adolescents engage in regular physical activity in addition to other diabetes-related health behaviors.² Adolescents with T1DM who meet the recommended goal of 60 minutes or more of moderate to vigorous physical activity (MVPA) at least 3 days per week may have better T1DM-related outcomes and quality of life.^{3,4} Many adolescents with T1DM do not engage in this level of routine MVPA.

For adolescents with T1DM, engaging in MVPA safely requires additional self-care behaviors, including blood glucose checks prior to, during, and after MVPA, adjusting insulin and dietary intake, assessment and treatment of potential hypoglycemia, and ketone testing. Common challenges faced by adolescents with T1DM include lack of knowledge, barriers to managing changes to insulin and dietary intake, and adolescent and parent fear of hypoglycemia.^{5,6} Moreover, adolescents with T1DM might believe that they are at risk for undesired disclosure to their peers when performing self-management behaviors during physical activity. Such disclosure can increase experiences of stigma,⁷ that could potentially result in emotional and psychological distress.⁸ Though interventions to prepare adolescents to meet the challenges of increasing MVPA safely have been developed and tested,⁹⁻¹² barriers to MVPA in this population persist.

Peer support is recommended for individuals with T1DM to reduce the burden of living with the condition, facilitate appropriate independence in self-management behaviors, and improve outcomes.⁸ Adolescent preferences for social connection and peer support may help to create interventions that are acceptable and sustainable. Despite the demonstrated benefits of interventions that facilitate the integration of T1DM self-management into daily life, programs are often underused and have not been able to engage a substantial proportion of the adolescent population with T1DM.¹³ We previously reported on the feasibility and safety of an intervention, Bright 1 Bodies, to increase MVPA and safe self-management behaviors in adolescents with T1DM.¹⁴ Since dissemination of interventions relies on uptake and sustainability, evaluating whether the Bright 1 Bodies intervention fits participant needs is a priority.¹³ Therefore, the purpose of this study was to examine youth and parent perspectives on the acceptability of this group physical activity and coping intervention for adolescents with T1DM.

Methods

Overview

The study was approved by the Yale University Institutional Review Board and a detailed description of the intervention methods and feasibility and safety results have been published.¹⁴ The focus of this paper is acceptability of the intervention from the perspectives of adolescents with T1DM and their parents following participation. We used the Theoretical Framework of Acceptability (TFA),¹⁵ described by Sekhon et al. as the extent to which people participating in an intervention considered it appropriate. The TFA includes seven domains of acceptability: (1)

affective attitude, or the participants' feelings about the intervention; (2) burden, the perceived effort required to participate in the intervention; (3) ethicality, or the alignment with values; (4) intervention coherence, or a participants' understanding of the intervention and how it works to effect change; (5) opportunity costs, or benefits given up by participants in order to participate (e.g., free time, financial cost); (6) perceived effectiveness, or the participants' expectation that the intervention will work; and (7) self-efficacy, or the participants' confidence in performing tasks required during the intervention. The TFA has been used to understand implementation success of interventions.¹⁶

Bright 1 Bodies Intervention

The aim of Bright 1 Bodies was to increase MVPA and safe self-management behaviors delivered in a group setting for adolescents with T1DM. The intervention was composed of 12 weekly sessions of MVPA group exercises (35 minutes) taken from the exercise component of the Yale Bright Bodies Weight Management Program for Children^{17,18} and group discussions of topics relevant to T1DM (45 minutes). During the sessions, parents were encouraged to gather informally to engage in facilitator-led physical activity and discussion of T1DM topics. The intervention was implemented in two community settings in close proximity to recruitment sites (i.e., diabetes clinic). Intervention components are summarized in Table 1, following reporting guidelines.¹⁹

Table 1. Bright 1 Bodies intervention components

Component	Bright 1 Bodies
Why (rationale, theory, or goal of the intervention)	<ul style="list-style-type: none"> • Engage adolescents with T1DM in MVPA using recommended safety practices
What (materials; procedures)	<ul style="list-style-type: none"> • Model appropriate behaviors for exercise with T1DM (e.g., blood glucose checks, ketones checks, available glucose source). Supervision provided by exercise physiologists and nurses. • Adolescents engaged in a series of discussions about self-management and role-playing scenarios around physical activity and social situations (e.g., disclosure, safety, conflict resolution, etc.) • Parents were encouraged to meet informally in a facilitator-led group while adolescents were participating in activities.
Who (intervention delivery, expertise, and training)	<ul style="list-style-type: none"> • Exercise group leaders (exercise physiology undergraduate students) • Discussion group leaders (nurse practitioner student, postdoctoral fellow)*
How (modes of delivery)	<ul style="list-style-type: none"> • In session exercise • Group discussion

	<ul style="list-style-type: none"> • Parent informal group discussion and/or physical activities (e.g., walks, aerobics)
Where (locations, infrastructure)	<p>Intervention settings were close to the two T1DM clinics where participants received care and recruitment took place.</p> <ul style="list-style-type: none"> • Elementary and middle school gymnasium • Private university exercise facility
When and how much (number of times delivered, what period of time, intensity, dose)	<p>90-minute sessions (10-minute check in, 35-minutes of physical activity, 45 minutes peer group discussion)</p> <ul style="list-style-type: none"> • One per week, for 12 weeks
Implementation challenges (describe the changes in changed during the course of the study)	<p>Rolling enrollment of participants for 12 week intervention</p> <ul style="list-style-type: none"> • Private university site had some access issues (e.g., lack of privacy, unfamiliar setting for most youth, lack of space for parents to meet) because it was a shared space.

*Some of these individuals were young adults with T1DM.

Participants and Recruitment

Participants were recruited from the patient population receiving care at the Yale Children's Diabetes Program. Adolescents, 11-19 years old, were approached during regular clinic visits and invited to participate in the intervention. Inclusion criteria included having diagnosed T1DM, sedentary lifestyle, and not taking medications or managing other conditions that would require special management of diabetes. Participants were cleared to engage in MVPA by their diabetes care providers. Parents were also invited to participate in the qualitative interviews. There were no inclusion/exclusion criteria for parent participation.

Data Collection

Participant Satisfaction Survey. A brief survey was administered following the intervention to assess participant satisfaction with the program components, comfort with the program, and perceptions of the group leaders. The survey included 24 items on a 5-point Likert-type scale (from strongly agree to strongly disagree).

Semi-Structured Interview. Intervention participants were invited to a semi-structured interview with their parents. Adolescents and their parents were interviewed together to encourage participation among youth who may be unfamiliar or uncomfortable with research interviews. The interview guide was semi-structured²⁰ to encourage adolescents and their parents to describe their experience in the intervention, including their perception of intervention components (i.e., safety measures, specific exercises, group discussions, assessments), program effectiveness, and suggested improvements. Interviews were conducted on the phone by a graduate student external to the intervention, audio-recorded, and transcribed. Transcripts were reviewed prior to analysis and updated for accuracy.

Data Analysis

Quantitative Analysis

Participant satisfaction surveys were summarized using descriptive statistics (e.g., means and frequencies). Subscales for program components, comfort with the program, and perceptions of the group leaders were totaled and summarized.

Qualitative Analysis

We used an inductive, descriptive approach²¹ to understand participant and parent experiences following the intervention. A descriptive approach allows the research team to provide detail about perspectives and experiences, relying heavily on participants' words rather than abstractions of their meaning or intent. Data management and analysis were supported by Atlas.ti 7 software (Berlin, Germany).

Two team members read through all transcripts and familiarized themselves with the data. We then created a list of codes and applied them to the transcripts. We reviewed the coded transcripts, assessing the appropriateness of the assigned code and reconciling any disagreements. All final codes were discussed and agreed upon by both reviewers. Next, we created "condensed meaning units" that integrated multiple codes into descriptive or interpretive concepts.²² Meaning units were applied to all transcripts, modifying or creating new units as needed. Finally, the units and accompanying quotes were used to build themes that incorporated multiple meaning units and original codes. Structured summaries were created for each theme by pulling all of the data associated with each theme, describing variation in participant experiences, and aligning findings with constructs from the TFA. We present the themes below with representative quotes and participant descriptors. Adolescent's ages are either "younger" (11-14 years) or "older" (15-19 years) to protect participant anonymity. TFA constructs are listed in parentheses after each related theme.

Results

All 18 adolescents completed the exit survey. Program components and strategies had a mean score of 4.5 (SD= 0.39), comfort with the intervention had a mean score of 4.4 (SD=0.44), and group leaders received a mean score of 4.3 (SD= 0.62). Sixteen adolescents (89%) completed the interview, fifteen with one parent and one with two parents. Of those who did not participate, one family had moved out of state and the other cited "personal reasons." Interviews lasted an average of 27 (SD= 8) minutes. Most participants were female (n=12) with a mean age of 14.1 years. Participant demographics are presented in Tables 2 and 3.

Table 2. Demographic data of children completing the exit interview (N=16).

Characteristic	Mean (SD) or Median (25th %'ile, 75th %'ile)
Age, years (SD)	13.8 (2.3)
A1C, % (SD)	9.5 (2.4)
Diabetes duration, years	1.7 (0.7, 5.2)

Insulin pump therapy, n (%)	6 (38%)
Gender, female (%)	11 (69%)
Race/ethnicity, n (%)	
Non-Hispanic White	5 (31%)
African American	4 (25%)
Hispanic White	6 (38%)
Asian	1 (6%)
Body mass index %'ile	90.8 (80.8, 95.0)
Weight, n (%)	
Normal weight (<85 th % 'ile)	6 (38%)
Overweight (≥85 th , <95 th %'ile)	4 (25%)
Obese (≥95 th %'ile)	6 (38%)

Presented as mean ±SD for normally distributed variables and median (25th %'ile, 75th %'ile) for non-normally distributed variables.

Table 3. Demographic data of parents completing the interview (N=17).

Characteristic	Mean (SD) or n (%)
Age, years (SD)	42.6 (6.9)
Gender, female	15 (88%)
Education	
<High School	1 (6%)
High School	6 (35%)
Trade school or college	8 (47%)
Missing	2 (12%)
Marital Status	
Single	9 (53%)
Married / Common Law	7 (41%)
Missing	1 (6%)
Income	
<\$20,000	5 (29%)
\$20,000 - \$39,999	4 (24%)

>\$40,000	6 (35%)
Missing	2 (12%)

Presented as mean $\pm$ SD for normally distributed variables.

Qualitative description resulted in four themes: (1) Adolescents and their parents valued the experience of being around others with T1DM and their families; (2) The intervention helped adolescents gain knowledge about and reinforce diabetes self-management behaviors, particularly related to physical activity; (3) Challenges for families with the intervention included convenience and sustaining participant engagement; and (4) Adolescents and their parents intended to sustain physical activity and diabetes self-management behaviors after the intervention. See Table 4 for a summary of themes, participant experiences, and related acceptability construct and Table 5 for additional representative quotes.

Table 4. Qualitative results from the descriptive analysis.

Theme	Participant experiences	Acceptability construct
Adolescents and their parents valued the experience of being around others with T1DM and their families.	<ul style="list-style-type: none"> Adolescents felt less isolated Adolescents shared challenges and strategies for managing T1DM Parents appreciated meeting and learning from older youth and young adults with T1DM Parents shared challenges and strategies with other parents 	Affective attitude; ethicality
Intervention helped adolescents gain further knowledge about and reinforce diabetes self-management behaviors, particularly related to physical activity.	<ul style="list-style-type: none"> Intervention emphasized the importance of healthy lifestyle (e.g., physical activity, nutrition) Youth participated in safety checks prior to physical activity (e.g., checking blood glucose) Youth gained insight regarding how physical activity impacts blood glucose 	Intervention coherence; Perceived effectiveness
Intervention challenges for families included convenience and sustaining participant engagement.	<ul style="list-style-type: none"> Families had scheduling conflicts and preferences that may have limited participation Location was inconvenient for some participants, though a second site was added Youth engagement may have been influenced by comfort with the intervention, perceived difficulty, and physical activity preferences Parents who participated in discussions gained informal support and knowledge about T1DM 	Burden; opportunity cost
Adolescents and their parents intended to sustain physical activity and diabetes self-	<ul style="list-style-type: none"> Youth reported incorporating additional physical activity into their daily lives Intervention was a fun, interactive, and social way to participate in physical activity 	Intervention coherence; self-efficacy

management behaviors after the intervention.	• Youth experienced positive changes (e.g., improved blood glucose, energy)

Theme 1: Adolescents and their parents valued the experience of being around others with T1DM and their families (affective attitude; ethicality).

Overall, adolescent and parent perceptions of the intervention were positive and aligned with their values. Adolescents and parents reported that they participated in the intervention to meet others with T1DM, learn more about T1DM, and improve their T1DM management and experience. The adolescents and their parents emphasized the value of “just hanging out with other people who had diabetes” (B1B01, older adolescent). Most adolescents had never met anyone else with T1DM, while a few had met someone through school, diabetes camp, or a penpal program. Interacting with others with diabetes allowed the adolescents to share the challenges they faced and strategies for managing diabetes. Adolescents were able to see that their experiences were shared by others living with diabetes. For example, one adolescent enjoyed the discussion component of the intervention, which helped her to feel less isolated having T1DM:

“I thought it was good how we all came together and we just talked about the situations we all went through. All of our own things that we go through in our lives. So, we could see something that we had in common and that we weren’t going through it alone” (younger adolescent).

Having shared experiences with their peers supported some youth to talk about their diabetes. In addition, teens gained practical guidance and recommendations from others about treatment options and self-management. For example, one participant had been considering switching from multiple daily insulin injections to an insulin pump prior to the intervention. While interacting with others, this participant learned about the possibilities, which helped her decision-making. Others described learning about how to manage specific circumstances, like going on field trips, participating in sports, or spending the night away from home.

Parents also had limited or no previous experiences with other youth who had T1DM. One parent shared:

“I’m glad to know, again, that there are other children, you know, similar ... You don’t want other kids to have it, but basically to know that you’re not alone, your child isn’t alone is a help” (parent of younger adolescent).

Others described the value of interacting with older adolescents and young adults who had been living with T1DM for longer than their children. Some parents described feeling comforted by seeing others who were healthy young adults, while others received informational support.

Finally, parents were invited to stay at the site for the duration of the intervention session, some had the opportunity to communicate with other parents. Just as the youth participants appreciated meeting and engaging with others with T1DM, parents described the value of the time spent

connecting with other parents who had similar experiences. One parent explained that “connecting to other parents” meant being able to “hear other parents tell their story” of diagnosis, which was “reassuring and supportive” (parent of younger adolescent). For the parents, support received from other parents of a child with T1DM was different than the support from family and friends because of their shared experience.

Theme 2: The intervention helped adolescents gain further knowledge about and reinforce diabetes self-management behaviors, particularly related to physical activity (intervention coherence; perceived effectiveness).

Overall, adolescents and their parents reported that the intervention increased their diabetes knowledge and improved health-related behaviors. Some parents indicated that the intervention emphasized the long-term importance of a healthy lifestyle for individuals with T1DM. One father explained:

“To me it’s a learning experience for them too, it is important that they understand that they need to do these things to help themselves live a long and happy life” (parent of younger adolescent).

Some youth reported that they learned about the importance of “taking better care” of their health: “There’s many consequences if you don’t take care of your body now, in the future” (older adolescent). Another adolescent agreed: “It [the intervention] helped me to know about what’s going on more, what healthy foods should I eat, make the right choices, try to be more active, and just try to stay healthy” (younger adolescent). Adolescents also described feeling “more confident” in living with T1DM because they learned more about diabetes, how to engage in self-management behaviors, and cope with diabetes: “Since starting the program I have felt more confident about it [managing diabetes] and learning a lot more than what they informed us with, and better ways to control it [diabetes], and deal with this all together” (younger adolescent). One parent emphasized how important it was to support his child in learning about diabetes self-management to “understand that they need to do this, without someone holding their hand, in the future” (parent of younger adolescent).

Physical Activity

Parents reflected that the sessions reinforced the importance of self-management behaviors, including regular glucose monitoring and physical activity. They also appreciated that the intervention included frequent precautions to ensure their child’s safety, including checking their glucose level prior to any activities. One parent described how these lessons created a sense of normalcy around self-management:

“And after you’ve engaged in high level activity you need to check your levels. And if you are low then you need to compensate for that. And you know... those types of things, it was nice to see, “Oh, everybody is doing this!” And what a nice sort of reversal of normalcy for me to see, and for my son to see” (parent of younger adolescent).

Parents indicated that reinforcing behaviors around checking blood glucose was important, particularly if their child was struggling with consistency or incorporating blood glucose monitoring into their daily routines.

The adolescents also described learning about different ways to exercise and how exercise affected their blood glucose levels. Because they monitored their blood glucose before and after exercise, they gained further insight into “how the [blood glucose] numbers work with exercise and activities throughout the day” by observing changes in the results (older adolescent). Another adolescent concluded:

“It just made me realize... I need to do exercise and it does help. I see that it helps with my diabetes and it helps with my sugar” (older adolescent). They also described feeling comfortable with the safety checks.

Group Discussions

During the group discussions, adolescents learned ways to manage stress, resolve conflict, and effectively communicate with others about diabetes. Overall, adolescents described preferring discussions that were interactive and activity-based: “The ones where we act out scenarios, those were my favorite! I think that we get to create the story in a way and then act it out, and it was really funny” (older adolescent). As described above, group discussions gave adolescents an opportunity to connect to others with T1DM. They reported feeling comfortable and less isolated when learning about and practicing T1DM self-management.

Several adolescents described gaining insight into how stress can negatively impact their blood glucose and relatedly, how to cope with stress to improve their T1DM management:

“We talked about how if there was anything going on in our social life, like with my friends... or online or if anybody was bullying us... it could make our sugars go higher, the stress could make our blood sugar shoot up to like 500s. We talked about what we could do and we even tried to meditate, and we listened to music” (younger adolescent).

Parent Discussions

In informal group discussions, parents often discussed diabetes challenges and successes, and occasionally participated in their own physical activity (e.g., indoor aerobics sessions, walking together outside). Parents described gaining diabetes knowledge, management guidance and support, and general social support from other parents:

“I liked the part of being able to get more information and talking to other moms to see what happened to their children, and different ways and things that they used, as in diets and exercise, to maintain their sugars, and to see their struggles as well. So it was a great place to meet and figure all of that out together” (parent of younger adolescent).

Theme 3: Intervention challenges for families included convenience and sustaining participant engagement (burden; opportunity costs).

Overall, the intervention was viewed positively. Participants described the intervention as “perfect,” “great,” and that the adolescents “liked everything.” The positive experience was summed up by this older adolescent: “I liked it because it was a lot of fun. The sports were varied, and everyone there was very nice.”

Convenience and Participation

Though participants generally enjoyed the intervention and felt it was successful, many also described logistical barriers, including: time, location, and the number of adolescents attending each week. The intervention sessions at one site were held weekly on Saturday mornings at 10 AM, which made it difficult for some families to make it on time. One parent laughed, “I know she didn’t want to go on Saturday” (parent of younger adolescent). Others appreciated the weekend option as opposed to weeknight. In addition, families had competing social opportunities (e.g., social gatherings) and family responsibilities (e.g., work, taking care of the house) that sometimes got in the way. However, for parents who were unable to bring the child to the session personally, transportation was provided.

The intervention was held in facilities suitable for physical activity in two different communities so it would be available for a broader range of families. Still, the location was not always convenient, and several participants suggested changing the location. One adolescent explained that the long drive sometimes felt like “a waste of the trip” and suggested longer sessions as a solution.

The intervention was structured so that adolescents would begin upon enrollment, but no cohort completed the full length of the intervention together. One adolescent described how this limited her ability to engage with others and develop relationships:

“In my first week, there were a lot of kids who, almost every kid who was there, their parents were [unintelligible], and then, I went away for a week, and then the week we came back, it was like a barren land, there weren’t as many kids and it just stayed that way for the rest of the time. It was like, ‘No, come back! We had these conversations, where are you going?’” (younger adolescent).

At the other site, which was added to better accommodate families who lived in the southern part of the health system catchment area, there were fewer adolescents. At times, only one adolescent attended: “It was only me... I was the only teen diabetic” (older adolescent).

Youth Engagement

Adolescent perceptions of individual exercises performed during the intervention varied. Some exercises were described as “normal” or similar to those the adolescents had performed while in physical education classes. Those who were already fairly active described the exercises as “very simple” or “easy.” Some adolescents suggested that making the exercises progressively harder or more competitive might help to sustain interest, while some youth suggested moving some of the activities outside. A parent added that games oriented toward building trust and comfort between adolescents may help with barriers to engagement, including feeling uncomfortable around new people.

Parent Engagement

While some parents appreciated the informal and flexible structure of these sessions, others described wanting more structured support for parents. For example, one participant suggested that parents have the opportunity to learn about and ask questions about the content for a

particular day. Parents also described inconsistency in who would engage in these sessions and how often. Some parents were disappointed that more did not participate:

“Some of the kids were simply dropped off and you never even saw the parents, other times I think the parents just wanted to sit out in the gym where the kids were doing their exercises” (parent of younger adolescent).

Theme 4: Adolescents and their parents intended to sustain physical activity and diabetes self-management behaviors after the intervention (perceived effectiveness; self-efficacy).

Youth participants and their parents reported intentions to maintain positive lifestyle changes after the intervention. Some participants stated they were either encouraged to maintain exercise or increase and improve their activity level. Youth described adding exercise to their weekly routines and feeling more motivated to be active. One participant said he was “a little less uneager to go on walks and stuff” and “willing to jump on the trampoline and mess around with the exercise ball” (younger adolescent). Both parents and youth believed that the exercises taught during the intervention helped to diversify the types of physical activity that youth would incorporate. While some parents described that they had been encouraging their child to exercise, the intervention provided an external source of motivation to engage in physical activity. Parents said that the intervention offered an alternative to exercise that was viewed as fun, interactive, and social.

Both youth and parent participants reported seeing positive changes that helped them to feel more empowered to manage T1DM. One parent described the intervention as “enlightening” because it helped them to “know that you can control what seemed uncontrollable,” as living with T1DM can sometimes feel. She continued: “You can control it [diabetes] if you make the necessary lifestyle changes to stay healthy” (parent of younger adolescent). An adolescent was encouraged to join her school’s track team, which she found improved her energy and stress management:

“When I run it feels like I get my mind off of things, like my mom said I zone out. It’s like when I run, it’s like a relief, it’s like a stress reliever. So if I have stress, I just run it out and then at the end I feel so much better, and I feel more happier, and I just had a lot of energy inside of me that finally just came out” (younger adolescent).

Parents and adolescents described seeing some of these positive changes in the youth’s blood glucose levels. For example, an adolescent reflected on the positive influence of exercise on her blood glucose levels: “It [the intervention] just made me realize like, exercise that kind of, I need it, I guess, I need to do exercise and it does help, with my, I see that it helps with my diabetes and it helps with my sugar” (older adolescent). These changes also had a positive impact on parents, who were often trying to encourage their child to take more responsibility for diabetes management. One parent described how the intervention improved her own stress about her child’s diabetes: “It calmed me down a lot, it also helped me worry less” (parent of younger adolescent).

Table 5. Themes, participant experiences, and representative quotes

Theme	Participant experience	Representative quote
Participants and their parents valued the experience of being around others with T1DM.	Youth were able to share their experiences, feel less isolated in having T1DM.	<p>“I feel like it would be more comforting to talk about my diabetes with people that I can trust and people that know what’s actually going on” (BB20, younger adolescent)</p> <p>“I did meet a few people, and it was kind of easy to talk to them compared to other people, like it was easier to talk about my diabetes with them, because it was more normal, more genuine” (BB18, younger adolescent)</p>
	Youth received practical guidance/ recommendations from others.	<p>“I thought it wouldn’t be bad to learn more about it [T1DM] and I would also be around a whole bunch of other people who have experienced it longer than I had it at the time... They’ve experienced many different types of things going through it and know how it felt like, going to school with it or like, field trips. Or staying with friends. And so I thought it would help being around people who have who had more knowledge about it” (BB07, younger adolescent)</p> <p>“I had this community of kids who didn’t have pumps and had pumps, and one of the kids was telling me all about his pump and I ended up going with the upgrade for his pump, so it was like, helpful to help me make decisions, regarding my management and how I’m going to go forward, it was helpful to have all these people who understood what I was talking about learned about a specific insulin pump from one of the other participants” (BB28, younger adolescent)</p>
	Parents connected with other parents about their shared experience, which was a source of information and support.	<p>“I wanted to learn more about diabetes because for me this is new. I didn’t know anything about diabetes except that it hits, like, older people. And when my daughter got diagnosed with diabetes it was a big shock, so I wanted to be involved with more people that were going through the same situation that I go through, and that way I’ll know that I wasn’t alone” (BB07, parent of younger adolescent)</p> <p>“We got together with a lot of parents that were going through the same situation that I was, and I guess we learned that everybody had a new experience and everybody was going through all... probably the same as me and, I don’t know, I felt comfortable, feeling that I’m not the only one going through this by myself” (BB20, parent of younger adolescent)</p>
Intervention helped to teach and reinforce self-management behaviors.	Intervention emphasized long-term benefits of healthy lifestyle.	<p>“There’s some really sad things that can happen if you don’t take care of your diabetes, so, I’m hoping to always stay in the know about it and I hope that she [my daughter] does too. She’s very proactive and I hope she continues to stay that way, and this program was a great start to, I’m hoping a continuous effort in trying to stay healthy” (BB23, parent of younger adolescent)</p> <p>“The study helped me realized that exercising is very important, but not only just exercising, but also like, healthy eating” (BB01, older adolescent)</p>
	Participants learned how physical activity impacted their blood glucose. (e.g., safety checks with blood glucose monitoring prior to/after physical activity, looking at	<p>“I got to be able to see how it worked in the beginning of the session, and then how my blood sugars changed at the end. Mine usually stood the same—like it was good and then it stood the same” (BB02, older adolescent)</p> <p>“I think exercising is a really good thing and [the intervention] would show her, without medicine, her numbers would come down before they started versus after they exercised, so I thought it was a great visual activity as well as physical, because it could really show you what your body is capable of” (B22, parent of younger</p>

	changes before and after exercise)	adolescent).
	Group discussion opportunity to connect to others with T1DM.	<p>“I thought it was good how we all came together and we just talked about the situations we all went through. All of our own things that we go through in our lives. So, we could see that something that we had in common and that we weren’t going through it alone” (BB07, younger adolescent)</p> <p>“It was also interesting when we would share stories and stuff, to learn about other people’s experiences and such. We did, one day, we broke into pairs, or groups of 3, and we shared our diagnosis stories... it was really interesting to hear how similar they were” (BB28, younger adolescent).</p>
Intervention challenges were primarily logistical, including timing, location, and the number of participants attending.	Positive view of intervention.	<p>“I mean the location was convenient, and, there was a manageable number of people, and, you know? The timing of it was fine, on a Saturday, it was a convenient time it wasn’t, you know, too early in the morning or too late, you still had most of your Saturday intact” (BB28, parent of younger adolescent)</p> <p>“I liked it because it was a lot of fun. The sports were varied, and everyone there was very nice. There was no one being rude or with an attitude. Everyone was very aware and paying attention that everything was going well at all times” (BB30, older adolescent)</p>
	Challenges related to convenience (timing, location, participation).	<p>“I would like it better if there were more people, because not a lot of people came, but the little group that we had was okay. There weren’t many people my age... I wish there were younger people” (BB17, younger adolescent)</p> <p>“If they can’t put it [the intervention] in other places then, like my mom said, there, it should be at least a little bit longer because they’re already there so, if you’re only there for like 2 hours or so, then it’s kind of a waste of the trip, because it’s a 45-minute trip, plus only 1 or 2 hours of the Bright 1 Bodies, and then 45 [minutes] back, the ride is longer than the actual thing” (BB18, younger adolescent).</p>
	Challenges related to engagement among adolescents.	<p>“I’m kind of shy... So maybe they [other teenagers] don’t want any people... With this program I think it might be a better opportunity to help them get out” (BB27, older adolescent).</p> <p>“Some people didn’t take it seriously” (BB18, younger adolescent).</p>
	Challenges related to engaging parents.	<p>“I think maybe sort of the next step thinking, moving forward, you know, critical feedback, would be around the idea of having some topics. Submitting the topics and say, you can talk about X, but is there something else you guys would like to talk about? Because sometimes I did feel that when we came together as parents we didn’t know what to talk about. So, the time that we spent conversing, sort of focused and maybe as meaningful as it could have been” (BB04 parent of younger adolescent)</p> <p>“My feedback is maybe to have a way to have like a feedback loop when the kids are engaging in these different experiences and activities there’s a way to sort of report back to the parents to say here’s why we’re doing it... you know, here’s how your kiddo</p>

		did, what questions do you have. I didn't feel like I was necessarily a partner in that process" (BB04 parent of younger adolescent)
Participants and their parents intended to sustain diabetes management lifestyle changes after the intervention.	Intervention encouraged youth to maintain or increase physical activity in daily life.	<p>"I like playing sports and all that, but it's hard for me to get motivated, I needed that motivation. They gave it to me" (BB27, older adolescent).</p> <p>"Before the study, I was just running on the treadmill. But then like ever since starting the study, when I got home, instead of only doing the treadmill I would do these workout videos that were suggested by [the group leader]" (BB01, older adolescent).</p>
	Youth and parents have seen positive changes in diabetes management	<p>"He's more energetic, and he's more, now, he's now more sociable to talk with, when he's around other kids, so that did change in his perspective in life. So, I'm very happy with the program" (BB08 parent of younger adolescent)</p> <p>"I think he [my son] has a better outlook on whole body exercise and why it's important to kind of incorporate core, arms, legs, you know upper body, lower body, and I think that he really likes when he's able to exercise and see his numbers, kind of stay more in the regulated zone than when they're out of control" (BB24 parent of older adolescent).</p>
	Youth and parents developed sense of empowerment to manage T1DM.	<p>"It helped stabilize my sugars in the morning, because I used to wake up with high blood sugars, but on Saturday, as soon as I went to the program, I would check my sugar, and it would be stabilized, and I would feel good about it" (BB17, younger adolescent).</p> <p>"It calmed me down a lot, it also helped me worry less. By her going, she went a lot, so when she would come back she was more knowledgeable, because she spoke with other children that had diabetes. So by her being around other children with the same disease, was great" (BB21 parent of younger adolescent).</p>

Discussion

The Bright 1 Bodies intervention that was designed to increase MVPA and safe self-management behaviors among adolescents with T1DM was largely viewed as a positive experience. Exit surveys demonstrated high scores for program components, comfort with the program, and perceptions of the group leaders. Qualitative results suggest that adolescents with T1DM and their parents found the intervention to be acceptable across multiple domains, particularly because of its involvement of other adolescents and group leaders with T1DM, reinforcement of diabetes self-management behaviors, and motivation to continue physical activity over time. Challenges included convenience for families and sustaining engagement over the duration of the intervention.

Overall, adolescents and their parents valued spending time with other youth with T1DM, demonstrating both a positive affective attitude toward the intervention and alignment with their values (i.e., ethicality). We expected that involving adolescents in a MVPA intervention with others with T1DM would eliminate barriers related to disclosure around T1DM, which can lead to discomfort or hesitancy for some youth.²³ Adolescents who worry about negative reactions among peers may avoid self-management tasks in social settings.²⁴ Instead, findings suggest that

the intervention helped to normalize self-management routines and support adolescents' confidence related to MVPA and self-care. Future research should investigate whether group interventions help to reduce negative perceptions of social interactions around diabetes self-management.

Parents gained emotional and informational support, particularly related to diagnoses and management of T1DM, which is consistent with research on parental needs.²⁵ However, as many participants described, finding other parents of children with T1DM is a challenge. Not surprisingly, research shows that parents often seek additional emotional and informational support through online communities of parents of children with T1DM.²⁶⁻²⁸ The impact of T1DM on family functioning and well-being is important to consider when designing interventions for youth, as poorer family functioning (e.g., family conflict, distress) has been related to poorer self-care behaviors, mental health, and glycemic levels among adolescents with T1DM.²⁹ Collaborative relationships between youth with T1DM and their parents, including support, problem-solving, and shared diabetes responsibilities, are associated with improved diabetes management and mental health.^{30,31}

Regarding intervention coherence, adolescents and their parents reported increased knowledge and skills around diabetes management and safe MVPA. Though many youth described already incorporating many of these health behaviors into their everyday lives, the intervention reinforced the need for these behaviors before, during, and after MVPA. Though most intervention studies designed to increase physical activity in youth with T1DM have not measured an impact on diabetes-related knowledge or self-management behaviors,³² improvements in self-care behaviors related to physical activity may be an important outcome that reduces barriers to MVPA. One such barrier, fear of hypoglycemia, can impact physical activity among individuals with T1DM across the lifespan.^{5,33-35} However, recent evidence suggests that vigorous physical activity is associated with lower fear of hypoglycemia and improved glycemic levels.^{36,37} Reducing fear of hypoglycemia among adolescents and their families may be a critical step to increasing MVPA in youth. It is possible that advancements in medical device technologies (e.g., continuous glucose monitoring) might make it easier for adolescents and their families to monitor glucose and make changes to prevent hypoglycemia during MVPA.

Our findings suggest that the intervention was effective in increasing MVPA and motivation to engage in regular MVPA following the intervention. In a qualitative synthesis of factors influencing physical activity among youth with T1DM, Dash et al found that self-management requirements, social support, enjoyment of activities, perceived health benefits, and knowledge of physical activity affected engagement.³⁸ Interventions to improve physical activity in youth with T1DM have shown significant benefits for A1C and other physical health measures (e.g., body mass index, triglycerides) and small improvements in psychological functioning.^{32,39-42} In the feasibility and safety evaluation of the present 12-week intervention, participants decreased their systolic blood pressure though there was no improvement in A1C or weight.⁴³ Parents believed that the social setting supported engagement in MVPA, particularly as it improved potential parent-child conflict related to exercise. As parents of younger children with T1DM often play an important role in MVPA through efforts to manage blood glucose, collaborating with youth as they age may be a source of conflict and a barrier to safe MVPA.⁴⁴

Despite the successes of the intervention, challenges remained that limited participation, including creating convenient and safe settings and sustaining engagement. Though there is support for personalized interventions to promote MVPA, our findings suggest that future MVPA interventions should leverage positive social interactions in group formats by including peers with T1DM. Emerging research suggests that adolescents with T1DM are open to peer interactions via diverse formats (e.g., online, text messaging, social media),⁴⁵ which would likely help to reduce some logistical barriers to participation. Additionally, engagement of parents in optional group activities was variable and reflected the flexible and informal nature of our program: parents were invited to take whatever role they desired, whether actively participating in group activities and discussions or dropping their child off at the site without participating. While this may have reduced burden for some families, others who regularly attended the intervention sessions each week would have preferred more formal and ongoing connection with more parents. Future research should investigate the acceptability of more structured group activities for parents of adolescents with T1DM.

Limitations

Our study has several limitations. The intervention took place at two community sites at different times of day, which created different experiences for participants. For example, one site had more enrolled participants, which likely influenced peer interactions during the group physical activity and discussion components. In addition, differences in the physical spaces (school gymnasium vs. dance studio) may have influenced adolescent and parent engagement in activities.

Adolescents and parents in this study completed the interview together. Though our intention was to increase comfort of youth participants who may not have experience with research interviews, adolescents may not speak as freely in front of their parents. Still, interviewers in this study encouraged both adolescents and parents to respond to each question in the interview protocol, and elaborate on the responses of the other.

Two adolescents who completed the intervention were unable to participate in the interview. These families may have had different experiences during the intervention, which are not reflected in the results. However, the majority of enrolled participants did complete the interview, providing detailed reflections on experiences and perceptions of the acceptability of the intervention.

Conclusion

Overall, adolescents with T1DM and their parents viewed a group physical activity and discussion intervention as acceptable across multiple domains. Adolescents and their parents valued an intervention that took place in a group setting with peers with T1DM, as it provided an opportunity to engage with, learn from, and be supported by others with a shared experience. The intervention taught and reinforced safe self-management behaviors in the context of MVPA, which helped adolescents and their families to feel more confident about exercise. Future MVPA interventions would likely benefit from integrating social interactions with others with T1DM.

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