An Individual versus Parent Supported Physical Activity Intervention in Adolescents with Intellectual Disabilities

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ABSTRACT

PTOMEY, L. T., R. A. WASHBURN, J. LEE, J. R. SHERMAN, A. M. RICE, J. C. DANON, D. A. WHITE, A. N. SZABO-REED, B. C. HELSEL, and J. E. DONNELLY. An Individual versus Parent Supported Physical Activity Intervention in Adolescents with Intellectual Disabilities. *Med. Sci. Sports Exerc.*, Vol. 56, No. 12, pp. 2256–2266, 2024. **Introduction:** Moderate-to-vigorous physical activity (MVPA) is inadequate in adolescents with intellectual and developmental disabilities (IDD). This report describes the results of an 18-month clinical trial in adolescents with IDD, which compared changes in accelerometer-assessed daily MVPA, gross motor quotient, and leg press strength between participants randomized to an exercise intervention delivered to adolescents only (AO) or to the adolescent and a parent (A + P). **Methods:** The 18-month trial included a 6-month active intervention, 6-month maintenance interventions, and a 6-month no-contact follow-up. Adolescents in both arms were asked to attend 40-min remotely delivered group video exercise sessions (0–6 months = 3 sessions per week, 7–12 months = 1 session per week). In the A + P arm, one parent/guardian was asked to attend all group remote video exercise sessions and a monthly remotely delivered 30-min educations/support session with their adolescent across the 12-month intervention. **Results:** Adolescents (n = 116) with IDD (age ~16 yr, 52% female) were randomized to the AO (n = 59) or A + P (n = 57) arms. Mixed modeling, controlling for baseline MVPA and season, indicated minimal but statistically significant changes in MVPA across 6 (P = 0.006), 12 (P < 0.001), and 18 months (P < 0.001). However, the change in MVPA in the two intervention arms did not differ significantly at any time point (all P > 0.05). Similarly, gross motor quotient and leg press strength improved significantly over time (P < 0.001), and these changes did not differ between intervention arms (all P > 0.05). **Conclusions:** Parental involvement had no impact on changes in daily MVPA, gross motor quotient, or leg press strength in response to a remotely delivered exercise intervention in adolescents with IDD. **Key Words:** AUTISM, DOWN SYNDROME, EXERCISE, TECHNOLOGY, REMOTE DELIVERY

The Physical Activity Guidelines for Americans recommends 60 min·d^{-1}, 7 d·wk^{-1} of moderate-to-vigorous physical activity (MVPA) for all youth aged 6–17 yr, including those with intellectual and developmental disabilities (IDD) (1). IDD is defined as a disability originating before age 10, characterized by significant limitations in both intellectual functioning (IQ < 75) and limitations in two or more adaptive behaviors (2). Inadequate daily MVPA participation in adolescents with IDD, which is lower than observed in adolescents without IDD (3–5), is associated with reduced cardiovascular and muscular fitness (6–9), poor motor skills (10,11), and a high prevalence of overweight and obesity (12,13). Thus, interventions to increase MVPA have the potential to improve both health and functional parameters, such as muscular strength and motor skills, in adolescents with IDD.

Adolescents with IDD face unique barriers to participation in MVPA, which contribute to the complexity of developing interventions to increase MVPA in this population. For example, exercise facilities often lack staff familiar with working with individuals with IDD, lack a partner to engage/support their participation in MVPA, rely on a parent to provide transportation to facilities to participate in MVPA, and are more dependent on assistance from their parents for daily life activities compared with adolescents without IDD (14). Parental engagement, which can provide direct modeling and an encouraging home environment (15,16), is generally considered to be an important facilitator of increased MVPA in children and adolescents with IDD (17). However, empirical evidence to support this hypothesis is limited to cross-sectional analyses, which suggest an association between parent and adolescent MVPA, when using both self-reported (18–20) and device-assessed MVPA (21)

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and one randomized pilot weight management trial, which included an MVPA component that demonstrated greater increases in accelerometer-assessed MVPA across a 6-month intervention, which included parental support/training ($n = 11$) versus the same intervention without parental support/training ($n = 10$) (22). We are unaware of any adequately powered randomized trials that have evaluated the impact of parental support on participation in MVPA in adolescents with IDD. Thus, this report describes the results from an 18-month trial in adolescents with IDD, which compared accelerometer-assessed daily MVPA between participants randomized to a home-based remotely delivered group exercise intervention delivered to adolescents only (AO) or the same home-based group exercise intervention plus education/support sessions delivered to both the adolescent and a parent (A + P).

METHODS

Overview

Adolescents with mild-to-moderate IDD and a parent were randomized to the AO and A + P arms for an 18-month trial, which included a 6-month active intervention, 6-month maintenance interventions, and a 6-month no-contact follow-up. Adolescents in both intervention arms were asked to engage in 60 $\text{min}\cdot\text{d}^{-1}$ of MVPA that included attendance at three remote exercise sessions per week (0–6 months) and one remote exercise session per week during months 7–12. Each exercise session included ~30 min of MVPA and was delivered to groups of ~6–8 participants in their home using Zoom® video conferencing (San Jose, CA) on an iPad® provided by the trial (Apple Inc, Cupertino, CA). Parents in the A + P arm were asked to participate in group exercise sessions and attended monthly one-on-one remotely delivered education/support sessions (FaceTime®) with their adolescent across both the active (0–6 months) and maintenance interventions (7–12 months). Group exercise and adolescent/parent education/support sessions were delivered by health coaches with experience with these interventions in adolescents with IDD. The same health coach delivered both the AO and A + P interventions in each cohort to reduce the potential for health coach effects.

Our primary aim was to compare changes in accelerometer-assessed daily MVPA ($\text{min}\cdot\text{d}^{-1}$) across 6-months between the AO and A + P arms. Secondarily, we compared between arm changes in MVPA, gross motor skills lower body muscular strength across 12 and 18-months. The Institutional Review Board at the University of Kansas Lawrence approved this trial, which was registered on ClinicalTrials.gov (NCT03684512) and conducted from February 2019 to October 2022. A detailed description of the rationale, design, and methods for this trial has been previously published (23). A brief description of the methods is included hereinafter.

Participant Eligibility

Participants were adolescents with mild-to-moderate IDD (age 10–21 yr, IQ 40–74) and a parent or guardian living in the home with the adolescent who also agreed to participate in the trial. Primary care physician clearance was required for both adolescents and the participating parent/guardian. In addition, adolescents were required to have sufficient functional ability to understand directions and the ability to communicate through spoken language. Adolescents or parents with serious medical risk, for example, cancer or a recent cardiac event, or those unable to participate in MVPA or without Internet access in the home were excluded.

Recruitment/Randomization

Cohorts of ~20–25 participants were recruited through community agencies serving individuals with IDD and using email list serves and media advertising (print, social media) to target families with adolescents with IDD living in the recruitment area. Written informed consent was obtained from the parent and from either the adolescent (self as guardian) or a legal guardian with adolescent assent. Treatment allocations using block randomization were generated by computer software after stratifying adolescents by sex and the presence or absence of Down syndrome with equal allocation to the AO and A + P arms. Four sibling pairs who enrolled in the intervention were randomized as a unit. Treatment allocations were concealed in envelops and revealed to the study coordinator as participants were recruited.

Intervention

MVPA recommendations (AO and A + P arms). Recommended daily MVPA progressed from ~15 $\text{min}\cdot\text{d}^{-1}$ during week 1 and gradually increased 10-$\text{min}\cdot\text{d}^{-1}$ every 2 wk to reach the 60-$\text{min}\cdot\text{d}^{-1}$ goal by week 11 and remained at 60 $\text{min}\cdot\text{d}^{-1}$ through 18 months.

Remote group exercise (AO and A + P arms) schedule. In each arm, two separate remote group exercise sessions were scheduled between 4 and 8 PM, 3 sessions per week from baseline to 6 months and 1 session per week during months 7–12. Participants attended the exercise sessions that fit their schedule. Participants only attended sessions within their exercise arm. *Exercise session content*: Each session included a warm-up (~5 min), moderate-to-vigorous intensity aerobic and resistance exercise (~30 min), and cool-down/stretching (~5 min). Sessions were accompanied by music and included exercises such as walking/jogging in place, dancing, imitating animal movements, vertical/horizontal jumps, squats, throwing, and catching movements using a throwing scarf, and TheraBand® resistance exercises for major muscle groups (Performance Health Group, LLC, Akron, OH). Exercises were modified for adolescents who were unable or had difficulty in performing specific movements. *Exercise session intensity:* The intensity of the exercise sessions progressed from light-to-moderate, that is, <64% maximum heart rate (HR_{max}) to moderate-to-vigorous, i.e., ≥64% HR_{max} (24) over the first 6 wk of the intervention and continued at moderate-to-vigorous intensity until the completion of the intervention (12 months). HR_{max} for adolescents without Down syndrome was estimated using the standard equation for children and adolescents (208 − 0.7 × (age in years) (25). HR_{max} for adolescents with Down syndrome was estimated as 210 − 0.56 × (age in years) − 15.5 × 2, as suggested by Fernhall et al. (26) to account for the lower HR_{max} associated with Down syndrome (6,27). Exercise intensity was documented using heart rate data obtained from a Fitbit® Versa activity tracker (Google, LLC Mountain View, CA) worn on the nondominant wrist. Adolescents were asked to trigger the Fitbit® at the beginning and end of the aerobic/resistance training portion of each exercise session to provide an assessment of intervention fidelity. Health coaches asked adolescents to verbally report their exercise heart rate at least once during each exercise session and were instructed to increase or decrease their exercise intensity if they fell below or above their prescribed target heart rate. The Fitbit® was also used for self-monitoring of daily physical activity across the 18-month trial as described hereinafter. Fitbit® data were transferred to a cloud storage platform (Fitabase®) maintained by Small Step Labs, LLC (San Diego, CA). Adolescents were encouraged to engage in MVPA outside the group exercise sessions to achieve their 60-min·d^{-1} goal. To assist participants with meeting their MVPA goals, video recording of all group exercise sessions was loaded on Dropbox® (Dropbox, Inc, San Francisco, CA), and access to information from the National Center on Health, Physical Activity and Disability, and the Special Olympics home training guide was all available on the adolescents' iPad®.

Self-monitoring physical activity (AO and A + P arms). Adolescents were asked to wear the Fitbit® all day-each day across the 18-month trial. Adolescents were reminded to wear, charge, and sync the Fitbit® to the iPad® during each group exercise sessions. Reminder messages were sent to the adolescent's iPad® if the Fitbit® was not synced during the previous week. Self-monitoring data were used to provide feedback and encouragement during exercise sessions in the AO arm and during education/support sessions in the A + P arm as described hereinafter.

Parental involvement (AO arm). By design, parental involvement in the AO arm was limited to receiving a maximum of three reminder contacts from the health coach each time their adolescent missed three consecutive scheduled exercise sessions.

Parent involvement (A + P arm). One parent was asked to attend all group remote video exercise sessions and a monthly 30-min education/support session with their adolescent. Education/support sessions were delivered remotely on their iPad® using FaceTime® across the 12-month intervention. The exercise intervention was designed for the adolescents; however, parents were asked to participate in exercise sessions and to provide support, encouragement, and assistance for adolescents having difficulty with any of the prescribed exercises. Education/support sessions, delivered by the health coach, were designed to assist parents in supporting their adolescent with meeting the 60-min·d^{-1} MVPA goal. Sessions included a review of the self-monitoring data from the Fitbit®, goal setting, and discussion of a topic relevant to MVPA. Topics included strategies for reducing barriers and incorporating MVPA into the daily schedule, appropriate types and locations for MVPA, alternative strategies for MVPA during inclement weather, and health and functional benefits associated with participation in MVPA, among others.

Incentives. Positive behavioral support programs, which provide modest incentives, have been successful in motivating behavioral change in individuals with IDD. Adolescents in this trial had the opportunity to earn stars generated and distributed using the Rooster money iPad® app (Rooster Money LLC, London, England), which could be exchanged for a monetary incentive. For example, adolescents had the potential to earn a maximum of two stars each week, one star for completing physical activity self-monitoring on 5 of 7 d and one star for attending two of the three scheduled exercise sessions (0–6 months) or the one exercise session over months 7–12. Adolescents were provided with \$10 Clincards (Greenphire Inc, King of Prussia, PA) each time they accumulated 10 stars. Adolescents also received \$50 Clincards for completing assessments (laboratory + 7-d accelerometer) at each of four time points (baseline and 6, 12, and 18 months) and \$25 for completing accelerometer assessments at 3, 9, and 15 months. In addition, adolescents were allowed to keep both the iPad® and Fitbit® on completion of the active intervention (12 months).

Outcome Assessments

Outcomes were assessed in our on-campus laboratory at baseline and at 6, 12, and 18 months by trained staff blind to intervention arm. All staff completed interrater reliability assessments for all measures before baseline testing and received refresher training and reevaluation of interrater reliability 2–3 times a year across the trial. Baseline testing for one cohort (AO, n = 10; A + P, n = 14) was conducted in May–June 2020 during the period when COVID-19 restrictions prohibited in-person participant contact and impacted our ability to collect baseline measures of our secondary aims (gross motor skills and lower body strength). Thus, secondary aim data for these 24 participants are not included in our analysis.

Primary Aim

MVPA (min·d^{-1}) was assessed using the ActiGraph wGT3x-BT portable accelerometer (ActiGraph Corp, Pensacola, FL) during daily activity over 7-d periods at baseline and at 3, 6, 9, 12, 15, and 18 months. Participants were instructed to wear the ActiGraph on a belt over the nondominant hip at the anterior axillary line during waking hours with the exception of bathing, swimming, and contact sports. Staff demonstrated proper ActiGraph placement and distributed ActiGraphs following completion of laboratory visits at baseline and at 6, 12, and 18 months. ActiGraphs for the baseline assessments of MVPA in COVID-19 cohort were distributed by mail. Staff demonstrated proper ActiGraph placement during a FaceTime® call with participants. ActiGraphs were also distributed by mail for all assessments at 3, 9, and 15 months, and returned by prepaid mail following completion of the 7-d assessments at all time points.

Reminders to comply with the ActiGraph protocol were delivered to adolescents iPad® each morning during the 7-d assessment period. ActiGraphs were initialized and downloaded using ActiLife Software version 6.13.3 and set to collect raw data at 60 Hz, which was aggregated over 60-s epochs. ActiGraph data were processed using a customized R program developed by our group. Nonwear time was assessed using the Choi algorithm, that is, at least 90 consecutive minutes of zero counts with a 1- to 2-min allowance for counts between 0 and 100 counts per minute (28). Wear time criterion that has been used in previous trials in both adolescents with (21,29–31) and without IDD (32), that is, at least 8 h on 3-d (minimum of 1 weekend day), was required for inclusion in the analysis. The age-specific vertical axis cut-points for children/adolescents proposed by Freedson et al. (33,34) were used to assess MVPA in adolescents younger than age 18 yr. The ActiGraph vertical axis cut-point (≥2020 counts·per minute) described by Troiano et al. and used in the 2003–2004 and 2005–2006 cycles of the National Health and Nutrition Examination Survey was used to assess MVPA in adolescents 18 yr or older (3,35).

Secondary Outcomes

Gross motor skills were assessed using the Test of Gross Motor Development—Second Edition (TGMD-2) (36). The TGMD-2 evaluates six-locomotor skills (run, hop, gallop, leap, horizontal jump, and slide) and six-object control skills (striking a stationary ball on a tee, dribble, catch, kick, overhand throw, and underhand roll). Study staff verbally described and demonstrated each skill. Following a practice trial, adolescents completed two trials of each skill, which were evaluated on 3–5 components as 1 (performs the component correctly) or 0 (unable to perform the component correctly). The sum of the raw scores over all 12 skills was converted to a Gross Motor Quotient as described by Ulrich (37). The Gross Motor Quotient is a standardized score (mean = 100, SD = 15) and represents the best estimate of gross motor development.

Lower body strength was assessed on a Cybex plate-loaded leg press machine (Life Fitness Inc, Franklin Park, IL). To reduce the risk of potential injury associated with assessing one-repetition maximum (1RM), we estimated 1RM leg press strength based on number of repetitions to fatigue that were completed using a weight that the adolescent was able to lift 10 times or less using the equation described by Brzycki (38), predicted 1RM = weight lifted/(1.0278 − 0.278 × number of repetitions completed).

Other Assessments

Body weight was assessed using a calibrated scale (Model #PS6600; Belfour, Saukville, WI).

Standing height was assessed using a portable stadiometer (Model: #IP0955; Invicta Plastics Limited, Leicester, UK). Body mass index (BMI) was calculated as $kg \cdot m^{-2}$.

Attendance for both adolescents and parents at group exercise and adolescent/parent education/support sessions was obtained from records maintained by the health coach and expressed as the percent of possible sessions. Attendance for both adolescents and parents was defined as being visible on the screen for the entire lesson.

Self-monitoring of daily physical activity was defined as the percentage of days (total days worn/total days enrolled in the intervention) with a minimum of 8 h of Fitbit® data between 6 AM and midnight.

The minutes of MVPA (≥3 METs) and average intensity of the group aerobic/resistance exercise sessions were estimated using heart rate data obtained from the Fitbit®.

Semistructured interviews were conducted by phone with a 20% random sample of adolescents and parents from both intervention arms to gather information that might be useful for improving the intervention including overall satisfaction with the intervention format, intervention length, and difficulties with compliance with the MVPA recommendations, among others.

Power and Analysis

Power. This trial was powered to detect a small to moderate effect (Cohen's $f = 0.14$) for change in MVPA from baseline to 6 months between the AO and A + P arms, assuming correlations of $r = 0.25$ among repeated measures (21 measurements = 7 d each at 0, 3, and 6 months). Power calculation using G*Power 3.1.9.2 (Heinrich-Heine-Universität Düsseldorf, Düsseldorf, Germany) indicated that a sample of 114 adolescents (57·arms) would provide 81% power to test overall between-arm differences (i.e., group effect) while accounting for 20% attrition. This sample size would also provide ≥80% power to detect a between-arm difference in change (i.e., group–time interaction) as small as $f = 0.09$. Secondary and exploratory analyses were underpowered in this study.

Analysis—primary aim. Mixed modeling for repeated measures was used to evaluate our primary aim—that is, to compare between-arm change in MVPA ($min \cdot d^{-1}$) from baseline to 6 months. The model examined overall between-arm difference in MVPA (i.e., group effect), linear/nonlinear change for MVPA over time (i.e., time effect), and between-arm difference for change in MVPA (i.e., group–time interaction), controlling for baseline MVPA and season of assessments (winter, spring, summer, fall).

Analysis—secondary aims. Mixed modeling for repeated measures was also utilized to assess our secondary aims—that is, to compare between-arm changes in MVPA ($min \cdot d^{-1}$), muscular strength, and gross motor quotient across 18 months. The models tested the group effect, time effect, and group–time interaction for these outcomes.

Other analyses. Using combined data from both intervention arms, mixed modeling examined the effects of age, sex, Down syndrome (yes/no), attendance at remote group exercise sessions, attendance at education/support sessions (A + P only), and self-monitoring of daily physical activity on MVPA over 18 months All analyses were conducted using R and SAS 9.4.

RESULTS

Randomization, Retention, and Baseline Characteristics

Adolescents. We randomized 116 adolescents with IDD to one of two intervention arms (AO, $n = 59$; A + P, $n = 57$). Adolescent retention at 6 months (AO = 92%; A + P = 82%, $P = 0.24$), 12 months (AO = 81%; A + P = 70%, $P = 0.16$), and 18 months (AO = 76%; A + P = 65%, $P = 0.19$) was similar in both intervention arms (Fig. 1). At baseline, adolescents with IDD were ~16 yr of age, 52% were female, 76% were White, and 55% had Down syndrome.

Parents. Four parents had multiple adolescents who enrolled in the intervention together; thus, a total of 112 parents were randomized to one of the two intervention arms (AO, $n = 57$; A + P, $n = 55$). All parents with multiple adolescents completed the 18-month trial; therefore, parent and adolescent retention was identical. Parents were ~48 yr of age, 92% were female, and 84% were White. Approximately 82% of parents had completed an associate degree or higher. There were no reported serious adverse events related for either adolescents or parents related to participation in the 18-month intervention (Fig. 1, Table 1).

Primary Aim

Change in MVPA (baseline–6 months). MVPA was low at baseline in both intervention arms (AO = 22 ± 29 min·d^{-1}, A + P = 17 ± 16 min·d^{-1}) and was essentially unchanged in both intervention arms at 6 months (AO = 19 ± 16 min·d^{-1}, A + P = 18 ± 14 min·d^{-1}). When controlling for baseline MVPA and season, mixed modeling indicated no significant between-arm difference in MVPA (group effect, $P > 0.05$) and no significant between-arm difference for change in MVPA (group–time interaction, $P > 0.05$) over 6 months. The time effect was significant for 6-month change in MVPA ($P = 0.006$); however, the magnitude of MVPA change in the total sample was minimal and opposite to the hypothesized direction (−2 min·d^{-1}; Fig. 2, Table 2).

Secondary Aims

MVPA across 12 and 18 months. Similar to the results across 6 months, mixed modeling of change in MVPA showed no significant between-arm difference for change in MVPA across 12 (AO = 2 min·d^{-1}, A + P = 8 min·d^{-1}) or 18 months (AO = 6 min·d^{-1}, A + P = 4 min·d^{-1}, both $P > 0.05$). The time effect for change in MVPA was significant at both 12 ($P < 0.001$) and 18 month ($P < 0.001$). However, the magnitude of change in MVPA in the total sample was minimal across both 12 (5 min·d^{-1}) and 18 months (5 min·d^{-1}) and of limited or no clinical relevance (Fig. 2, Table 2).

Gross motor quotient. Baseline motor quotient standard scores were classified as "poor" according to standards described by Ulrich (37). However, motor quotient standard scores improved

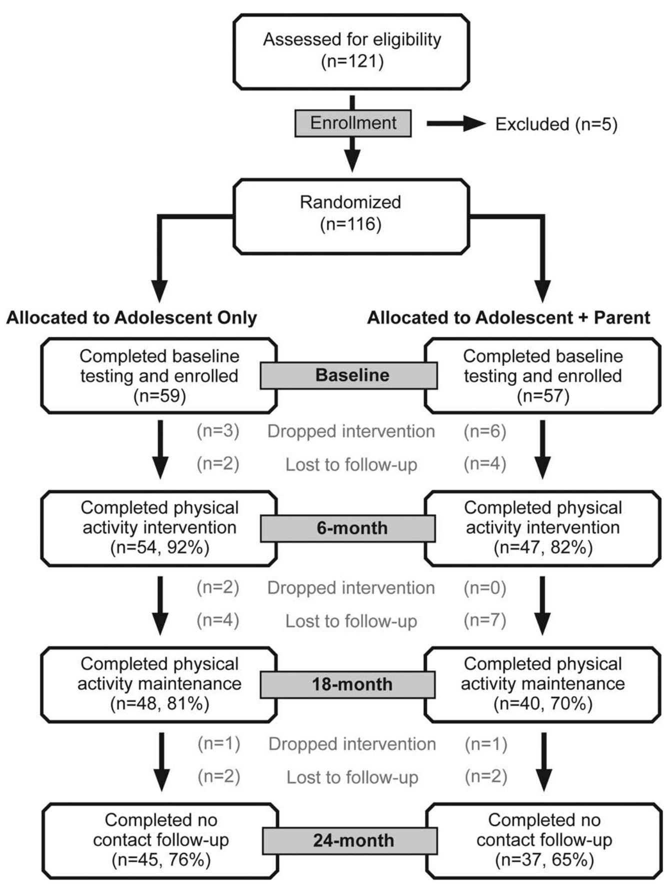

FIGURE 1—Consort diagram.

TABLE 1. Baseline characteristics of adolescents and a parent with IDD by intervention arm.

Variable	Adolescent Only	Adolescent + Parent
Adolescent sample	*n* = 59	*n* = 57
Parent sample	*n* = 57	*n* = 55
Adolescent age (yr)	15.4 (3.1)	15.6 (2.9)
Parent age (yr)	47.7 (7.4)	48.6 (7.0)
Adolescent BMI ($kg \cdot m^{-2}$)	26.2 (6.5)	28.2 (6.6)
Parent BMI ($kg \cdot m^{-2}$)	NA[a]	NA[a]
Adolescent female, *n* (%)	28 (46.7)	35 (58.3)
Parent female, *n* (%)	52 (91.2)	51 (92.7)
Adolescent race, *n* (%)		
White	43 (72.9)	45 (78.9)
Black	6 (10.2)	4 (7.0)
Other	10 (16.9)	8 (14.0)
Parent race, *n* (%)		
White	46 (80.7)	48 (87.3)
Black	7 (12.3)	4 (7.3)
Other	4 (7.0)	3 (5.5)
Adolescent Hispanic/Latino, *n* (%)	4 (6.8)	5 (8.8)
Parent Hispanic/Latino, *n* (%)	3 (5.3)	3 (5.5)
Adolescent IDD diagnosis, *n* (%)		
Down syndrome	32 (54.2)	32 (56.1)
Autism	15 (25.4)	14 (24.6)
Other IDD	14 (23.7)	12 (21.1)
Parent education, *n* (%)		
High school graduate/GED or less	2 (3.5)	2 (3.6)
Some college	7 (12.3)	8 (14.5)
Associate/bachelor's/graduate	48 (84.2)	45 (81.9)

[a] Not assessed.

in both intervention arms over 6 months (AO = 7; A + P = 8), 12 months (AO = 12, A + P = 15), and 18 months (AO = 7, A + P = 13) and were classified as "below average" at each time point. Mixed modeling indicated a significant time effect for change in motor quotient standard scores over 6, 12, and 18 months (all $P < 0.001$); however, no significant effect of group (all $P > 0.05$) or group–time interaction (all $P > 0.05$) was observed. Improvements were similar for locomotor skills (standard score) over 6 months (AO = 0.6; A + P = 1.2), 12 months (AO = 1.6, A + P = 2.4), and 18 months (AO = 1.1, A + P = 1.6) and improvements in object control (standard score) over 6 months (AO = 0.9; A + P = 0.6), 12 months (AO = 1.5, A + P = 1.6), and 18 months (AO = 0.8, A + P = 1.7; Fig. 3, Table 2).

Lower body strength. Mixed modeling indicated a significant time effect for change in predicted 1RM leg press over 6, 12, and 18 months (all $P > 0.001$); however, no significant effect of group (all $P > 0.05$) or group–time interaction (all $P > 0.05$) was observed (Fig. 4).

TABLE 2. MVPA, motor quotient, and leg press strength of adolescents with IDD across 18 months by intervention arm.

	Adolescent Only		Adolescent + Parent		
	n	Mean (SD)	*n*	Mean (SD)	*P*
MVPA ($min \cdot d^{-1}$)					
Baseline	52	22.2 (29.2)	44	17.0 (15.6)	0.28
3 months	41	26.2 (31.3)	32	22.9 (22.5)	0.60
6 months	42	18.7 (16.1)	31	17.9 (14.2)	0.82
9 months	36	21.8 (21.6)	24	19.3 (15.0)	0.61
12 months	36	24.0 (22.8)	25	24.8 (22.5)	0.89
15 months	33	25.4 (29.4)	22	31.7 (34.6)	0.48
18 months	32	27.9 (23.0)	23	20.6 (23.2)	0.25
Gross motor quotient (standard score)					
Baseline	49	77.6 (19.9)	43	76.1 (20.8)	0.68
6 months	45	84.1 (20.5)	31	82.8 (18.8)	0.75
12 months	38	87.9 (20.6)	31	88.2 (19.7)	0.93
18 months	38	83.2 (20.5)	31	86.5 (20.6)	0.47
Leg strength (kg)					
Baseline	44	67.7 (29.5)	41	77.6 (32.1)	0.15
6 months	42	80.6 (32.0)	30	87.6 (33.1)	0.37
12 months	33	86.7 (30.8)	24	95.0 (36.0)	0.37
18 months	30	92.1 (31.3)	20	104.1 (43.7)	0.30

[a] Assessed using a predicted 1-rep max leg press.

Other Outcomes

Adolescent attendance at group exercise sessions. There were no significant differences between intervention arms in the percentage of group exercise sessions attended by adolescents during either the active (baseline–6 months; AO = 69%, A + P = 63%, $P = 0.16$) or maintenance interventions (7–12 months; AO = 65%, A + P = 57%, $P = 0.26$). The percentage of adolescents attending more than 75% of scheduled group exercise sessions was higher in the AO (45%) compared with the A + P arm (29%), whereas the percentage of participants attending less than 50% of scheduled group exercise session was higher in the A + P (42%) compared with the AO arm (29%) ($P = 0.012$).

Parent attendance. Parents in the A + P arm attended 41% of group exercise sessions and 76% of education/support sessions during the 6-month active intervention, and 33% of group exercise sessions and 64% of education/support sessions during the 6-month maintenance intervention.

Self-monitoring of daily physical activity. There were no significant differences between the AO (78%) and A + P arms (81%) in the percentage of days that adolescents

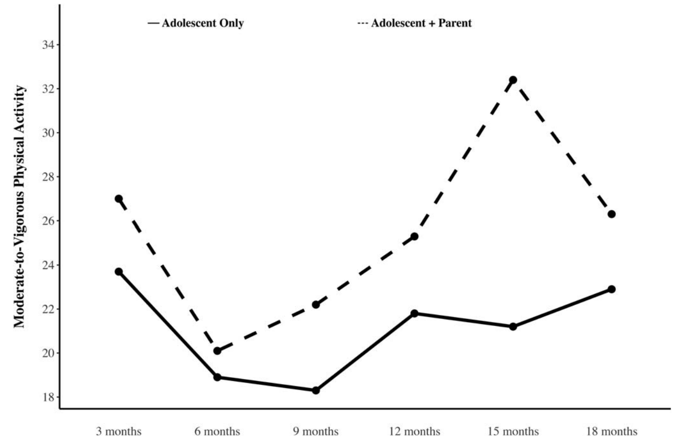

FIGURE 2—MVPA across an 18-month physical activity intervention in adolescents with IDD by intervention arm.

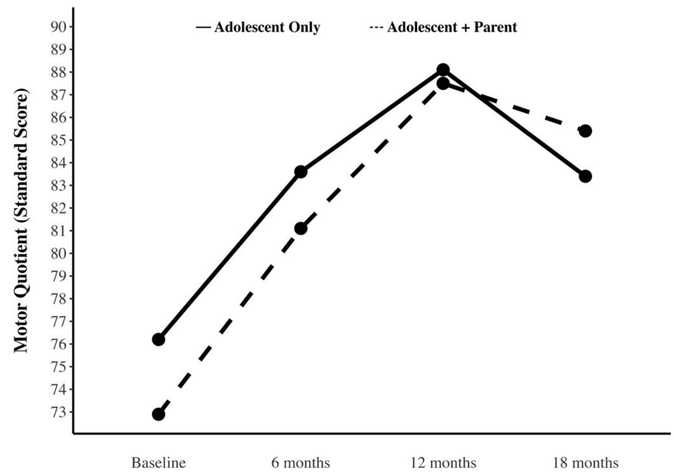

FIGURE 3—Motor quotient scores across an 18-month physical activity intervention in adolescents with IDD by intervention arm.

monitored their daily physical activity using the Fitbit® over 12 months ($P = 0.50$).

The minutes of MVPA and average intensity of the group aerobic/resistance exercise sessions. The average minutes of MVPA and exercise intensity during group sessions were similar in the AO (18 min per session, 62% HR_{max}) and A + P arms (19 min per session, 63% HR_{max}). Exercise intensity was lower in participants with Down syndrome (59% HR_{max}) compared with those with other IDD (66% HR_{max}) over 12 months.

Factors associated with change MVPA. Sex, Down syndrome diagnosis, and adolescent attendance at group remote exercise sessions in the total sample (AO and A + P arms) were not associated with change in MVPA over 6, 12, and 18 months (all $P > 0.05$). In the A + P arm, parent attendance at both group exercise and education/support sessions was not associated with changes in adolescent MVPA across 6, 12, or 18 months (all $P > 0.05$).

DISCUSSION

The primary aim of this trial compared changes in accelerometer-assessed daily MVPA across 6 months between adolescents with IDD randomized to a three-session-per-week (~40 min per session) home-based remote group exercise intervention delivered to AO or the same home-based group exercise intervention plus education/support sessions delivered to both adolescents and a parent. MVPA across 6 months was essentially unchanged in both intervention arms with no significant intervention arm–time interaction. Similar to the results across 6 months, we found no significant differences for change in MVPA between intervention arms and no significant intervention arm–time interaction following completion of both a 6-month maintenance intervention (AO = 2 $\text{min}\cdot\text{d}^{-1}$, A + P = 8 $\text{min}\cdot\text{d}^{-1}$) and a 6-month no-contact follow-up (AO = 6 $\text{min}\cdot\text{d}^{-1}$, A + P = 4 $\text{min}\cdot\text{d}^{-1}$, both $P > 0.05$).

Our results are consistent with the limited literature, which suggests that interventions designed to increase daily MVPA in adolescents with IDD are generally ineffective regardless of the level of parental support. Results from cross-sectional studies suggest an association between parental support and higher parent proxy reported (19,20) or accelerometer-assessed MVPA (18–20) (21). However, the results from intervention trials, including the current trial, and two additional small sample pilot interventions provide limited evidence for the effectiveness of parental support for improving MVPA in this population (22)˙ (39). For example, results from a 6-month pilot weight loss intervention in a small sample adolescents with IDD ($n = 21$), which included a recommendation for increased MVPA, found that accelerometer-assessed MVPA increased 18 $\text{min}\cdot\text{d}^{-1}$ ($P = 0.01$) in participants randomized to a 16-session in-person group intervention (4–5 participants) that included nutrition and activity education plus a behavioral intervention for parents ($n = 11$) and decreased 7 $\text{min}\cdot\text{d}^{-1}$ ($P = 0.30$) in adolescents randomized to the same nutrition and activity intervention without parental behavioral education ($n = 10$) (22). The parent intervention included instruction on behavioral strategies such as diet/activity monitoring, modification of "stimulus control" conditions at home, daily/weekly goal setting, and positive reinforcement. In contrast, physical activity assessed by parental self-report was unchanged across a 10-wk (18-session) single-arm intervention designed to improve physical activity, dietary habits, and overall health in a small sample of overweight adolescents with IDD and a parent ($n = 22$) implemented at two special needs schools (39). Interventions to increase MVPA delivered to adolescents with IDD without parental involvement have also been ineffective (37,40,41). For example, Shields et al. (41) reported no significant differences in accelerometer-assessed daily MVPA between adolescents with Down syndrome ($n = 68$, age ~18 yr) who were randomized to a 10-wk. community-based, physiotherapy student-mentored progressive resistance training program ($n = 34$) or a social activity control ($n = 34$). Shields and Taylor (37) also reported no significant differences in accelerometer-assessed daily MVPA between young adults with Down syndrome (age ~21 yr) who completed an 8-wk community-based physiotherapy student-mentored walking intervention ($n = 8$) or a social activity control ($n = 8$).

In the current trial, a parent of adolescents with IDD randomized to the A + P arm was asked to attend all group remote exercise sessions and 30-min remotely delivered education/

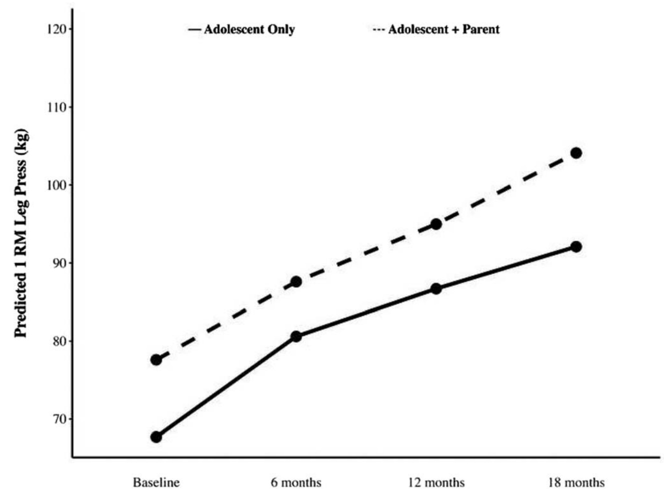

FIGURE 4—Lower body strength across an 18-month physical activity intervention in adolescents with IDD by intervention arm.

support session with their adolescent across the 12-month intervention. Parent attendance at the education/support sessions was reasonable during both the active (0–6-months, 76%) and maintenance interventions (7–12 months, 64%). However, parent attendance at group remote exercise sessions was poor during both the active (41%) and maintenance interventions (33%). Information obtained from semistructured interviews conducted with adolescents and parents, and feedback from health coaches who delivered the group exercise sessions, suggested that adolescents preferred to exercise with groups of their peers without a parent, which is likely associated with the poor parental attendance at group exercise sessions. Adolescents with IDD are more reliant on their parents for assistance with daily life compared with adolescents without IDD. However, similar to adolescents without IDD, they also desire some level of independence and value peer interactions and support (42–44). Our observations regarding parental involvement and peer support are consistent with those from two recent qualitative reports on the development of interventions to increase physical activity in adolescents/young adults with IDD, which suggested that the opportunity for interaction with peers was a primary facilitator of physical activity engagement (42,45) and indicated that, although younger adolescents (14–15 yr) were open to exercising with a parent, older adolescents/young adults (17–22 yr) were not (46).

We assessed MVPA using vertical axis data from a waist-worn ActiGraph and applied activity intensity cut-points for typically developing children/adolescents, as cut-points specific to adolescents with IDD are not currently available. Thus, the absolute minutes of MVPA observed in the current trial could be questioned. However, the high test–retest reliability of ActiGraph assessments of MVPA (47,48) adds confidence to the validity of our results for change in MVPA across the intervention regardless of the validity of our assessment of the absolute minutes of MVPA. Our finding of no significant change in MVPA across the intervention may be partially explained by the inability of the vertical axis of waist-worn ActiGraph to detect several of the movements included in the group exercise sessions, for example, walking/running in place, high knees, dancing, mimicking animal movements, arm circles, and side-to-side bends, among others. In contrast, heart rate data collected during group exercise sessions via the Fitbit® indicated that participants completed ~19 min of MVPA minute per exercise session. Thus, when accounting for the average attendance at exercise sessions of 66%, participants performed ~38 min·wk^{-1} across the 6-month active intervention, which was not reflected in our ActiGraph results. The significant improvements in gross motor quotient and leg strength observed in both intervention arms across 6 months also suggest that increases in MVPA not captured by the ActiGraph may have occurred. Improvements in these physical outcomes may be particularly relevant for adolescents with IDD through their association with better performance of activities of daily living and higher rates of employment, and independence in adulthood in adolescents with IDD (49–51). These observations regarding physical activity assessment highlight the need for additional work to develop ActiGraph protocols and procedures for the assessment of physical activity specific to adolescents with IDD, for example, the use of wrist-worn ActiGraphs, which have been associated with improved compliance with physical activity assessment protocols in adults without IDD (52) (17), and the collection and analysis of vector magnitude raw acceleration data (sum of all three axes) to classify activity intensity (53). Participants in the current trial wore the Fitbit® on their wrist ~80% of total study days across 12 months, suggesting that wrist-worn accelerometers may be acceptable for use in adolescents with IDD and potentially provide better wear time compared with accelerometers worn at the waist.

In the current trial, parental involvement (i.e., attendance at group remote exercise and education/support sessions) had no significant impact on daily MVPA in adolescents with IDD.

Although this result was disappointing, there were several positive aspects associated with the remote group exercise intervention to consider. Information obtained from semistructured interviews indicated that adolescents enjoyed the group exercise sessions, which was reflected in the relatively high attendance (66%) across 6 months. In addition, participants completed ~18 min per session of MVPA at an average intensity of ~62% HR_{max}. These results are consistent with those from a 12-wk. remote home-based group exercise pilot trial (three sessions per week) in 29 adolescents with IDD and minimal parent support conducted in preparation for the current trial. Pilot trial participants attended 77% of exercise sessions and completed ~12 min per session of MVPA at an average intensity of ~63% HR_{max} (54). Thus, remote group exercise provides a viable approach for the delivery of MVPA to adolescents with IDD. The remote approach eliminates the need for parents to transport participants to an exercise facility and provides the potential for peer social interaction and support, and the ability to reach participants regardless of geographic location, which may be especially relevant for adolescents with IDD who live in rural communities where adaptative sports/exercise programs and facilities are limited or unavailable. In addition, remote delivery provides service agencies or other entities supporting adolescents with IDD a cost-efficient strategy for delivering physical activity to this underserved population. Our results suggest that remotely delivered group exercise with minimal parent involvement could form the core of an intervention to increase daily MVPA in adolescents with IDD. Future work to develop strategies to improve engagement in MVPA outside the group exercise sessions such as the inclusion of an ecological momentary intervention component based on real-time data from the Fitbit®, inclusion of periodic participant challenges to try a new form of activity, and promotion of participation in community-based exercise opportunities such as training for and completion of a 5-km walk should be conducted.

Strengths of this trial include a randomized design with a sample size (*n* = 116), which provided adequate power to evaluate the primary aim, inclusion of a 6-month no-contact follow-up after completion of the 12-month intervention, the use of an intervention tailored to the barriers and abilities of adolescents with IDD, and acceptable participant attendance at group remote exercise sessions (0–6 months = ~66%, 7–12 months = ~61%) and acceptable participant retention across the trial (6 months = 87%, 12 months = 76%, 18 months = 71%). Compliance with the accelerometer assessment protocol, our inability to detect MVPA during group exercise sessions using the accelerometer, and the impact of the COVID-19 pandemic represent potential weaknesses of this trial. Compliance values with the physical activity assessment protocol using waist-worn accelerometers in the current trial were 83%, 77%, 71%, and 65% at baseline and at 6, 12, and 18 months, respectively. Although consistent with other trials in individuals with IDD where compliance with waist-worn accelerometer protocols ranged from ~45% to 100% (55), the rate of compliance with waist-worn accelerometers in individuals with IDD continues to be problematic.

As described previously, the evaluation of wrist-worn accelerometers and data collection/processing strategies for both wrist- and waist-worn accelerometer may improve both compliance with accelerometer protocols, and the ability to detect a wider range of types of physical activities will be important for future trials designed to improve MVPA in adolescents with IDD. Although unquantifiable, COVID-19 may have also impacted participant attendance at group exercise sessions and participant retention in addition to our inability to obtain secondary outcomes on one cohort of participants. Finally, this trial was conducted in a sample of community dwelling with adolescents with mild-to-moderate IDD who volunteered, and were incentivized, to participate in a physical activity trial. Thus, these results may not be generalizable to adolescents with more severe IDD or outside of the context of a research trial.

CONCLUSIONS

Parental involvement had no impact on changes in daily MVPA in response to a 12-month intervention, which included remotely delivered group exercise sessions and recommendations for engaging in daily MVPA in adolescents with mild-to-moderate IDD. Our results suggest that remotely delivered group exercise sessions with minimal parental involvement may form the core of interventions to increase daily MVPA in adolescents with IDD. Additional trials to evaluate strategies for improving engagement in MVPA outside the remote group exercise sessions are warranted. If ultimately shown to be effective, the remote group exercise approach has the potential to improve reach, adoption, implementation, and maintenance and provide service agencies or other entities supporting adolescents with IDD with cost-efficient strategy for improving daily MVPA in this generally sedentary and underserved population.

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The results of the current study are presented clearly, honestly, and without fabrication, falsification, or inappropriate data manipulation.

Data Availability Statement: Deidentified individual participant data (including data dictionaries) will be made available, in addition to study protocols, the statistical analysis plan, and the informed consent form. The data will be made available upon publication to researchers who provide a methodologically sound proposal for use in achieving the goals of the approved proposal. Proposals should be submitted to the corresponding author at lptomey@kumc.edu. Data are also available on ClinicalTrials.gov (NCT03684512).

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