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Journal
The Journal of School Nursing, 35(6)

ISSN
1059-8405

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Publication Date
2019-12-01

DOI
10.1177/1059840518786782

Peer reviewed

HHS Public Access
Author manuscript
J Sch Nurs. Author manuscript; available in PMC 2020 December 01.

Published in final edited form as:
J Sch Nurs. 2019 December ; 35(6): 449–461. doi:10.1177/1059840518786782.

Pilot Trial of an Acceptance-Based Behavioral Intervention to Promote Physical Activity Among Adolescents

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Abstract

Background—Prior interventions have shown limited efficacy in increasing the number of adolescents engaging in adequate physical activity. Preliminary evidence suggests acceptance-based treatments (ABT) may increase physical activity; however, this approach has not been tested in adolescents. This study was a non-randomized experimental pilot study that examined feasibility, acceptability and treatment outcomes of an acceptance-based behavioral intervention for physical activity in adolescents delivered in a school setting.

Methods—Adolescents (n=20) with low activity received a physical activity tracking device and were allocated to device use only or device use plus 10-weeks of ABT. Physical activity, cardiovascular fitness, and physiological outcomes were measured pre- and post-intervention.

Results—The intervention was found to be feasible and acceptable. Physical activity, cardiovascular, and physiological outcomes improved over time in the intervention group, but not in the comparison condition.

Conclusions—This study demonstrated feasibility, acceptability, and preliminary treatment efficacy based on effect sizes for an acceptance-based behavioral intervention to increase physical activity in adolescents with low activity. Future efficacy testing is warranted.

Keywords

Physical Activity; School-based; Adolescent; Acceptance-based; ACT

Introduction

Engaging in physical activity (PA), particularly moderate-to-vigorous PA (MVPA), is associated with many benefits, including lower all-cause mortality, lower risk of coronary artery disease, and lower blood pressure (Arem et al., 2015; Brook et al., 2013; Lahti, Holstila, Lahelma, & Rahkonen, 2014; Lee et al., 2011; Warburton, Charlesworth, Ivey,

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The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Nettlefold, & Bredin, 2010). PA is especially important among adolescents because low PA in childhood predicts low PA in adulthood, and long-term low PA increases the risk for a number of adverse health conditions, including obesity, type 2 diabetes, and cardiovascular disease (Brown, Burton, & Rowan, 2007; Kwon, Janz, Letuchy, Burns, & Levy, 2015; Reiner, Niermann, Jekauc, & Woll, 2013; Warburton, Nicol, & Bredin, 2006). Despite these risks, 75% of adolescents do not meet the current guidelines for activity (60 minutes a day) (Fakhouri et al., 2014). Therefore, interventions targeting adolescent PA are essential to protecting the future health of today’s youth.

School-based interventions are a promising format for increasing adolescent PA because adolescents spend approximately half of their waking hours in school during the school year. Additionally, the National Heart Lung and Blood Institute Expert Panel recommended that PA be promoted in schools because of the number of students school-based interventions can reach (Committee on Physical Activity and Physical Education in the School Environment, Food and Nutrition Board, & Institute of Medicine, 2013; National Heart, Lung, and Blood Institute, 2011). School nurses and other school health professionals are particularly poised to promote PA in schools because of their position as influencers of school health, their training, ongoing presence in schools, and their availability to students at no-cost (NASN, 2014; Schroeder, Travers, & Smaldone, 2016).

Unfortunately, school-based interventions to increase PA among adolescents have shown limited efficacy to date, particularly for increasing the proportion of adolescents engaging in MVPA. A 2013 Cochrane review of randomized controlled trials targeting PA participation through school-based interventions identified five studies that examined the impact of the intervention on rates of PA participation (i.e., the proportion of active adolescents) (Dobbins, Husson, DeCorby, & LaRocca, 2013). Only one of these five studies reported a positive effect of the intervention on the proportion of physically active adolescents: 79% of adolescents in the intervention condition (vs. 47% in the control) reported at least one supervised activity outside of school physical education (PE) classes (Simon et al., 2008). Although the Cochrane review (2013) found that 12 out of 23 randomized controlled trials demonstrated an impact of school-based interventions on mean duration of PA, none of these studies reported a positive impact on the proportion of adolescents engaging in MVPA, suggesting that the impact on mean activity may have been from getting already active adolescents to increase their activity levels. Another review of 14 studies testing PE class-based interventions revealed that the interventions showed an average increase in duration of MVPA during PE; however, none of these studies reported the proportion of active adolescents (Lonsdale et al., 2013). Lastly, a large study (n=1150) demonstrated that a school-based intervention was able to stop the decline in adolescent PA, but was not able to change the proportion of adolescents meeting the activity recommendations (Sutherland et al., 2016). In summary, there is very little evidence supporting the efficacy of school-based interventions for transforming non-active adolescents into active adolescents, leaving many students still at risk for long-term low PA.

The majority of the interventions reviewed above utilized environmental or informational strategies to promote PA (e.g., games in PE class, psychoeducation on the benefits of activity). The relative lack of attention given to individual adolescents’ enjoyment and affective experiences during PA may help to account for the disappointing results to date. Hedonic theory states that people are motivated to engage in activities they find pleasurable, and affect, “the most elementary consciously accessible affective feelings (and their neurophysiological counterparts) that need not be directed at anything” is an important determinant of PA (Kahneman, 1999; Russell & Barrett, 1999; Schneider, Schmalbach, & Godkin, 2017; Williams, 2008). Research suggests that increased positive affect, indicating greater enjoyment, during PA predicts greater PA among adolescents and adults both in lab-based studies and studies which predict PA behavior up to 6 months after affect measurement (Rhodes & Kates, 2015; Schneider, Dunn, & Cooper, 2009; Williams, 2008).

Despite this link between affect and PA, promoting PA that “feels good” does not seem to be effective for increasing PA engagement in adolescents (Schneider et al., 2017). In a full-scale randomized controlled trial that tested the effects of promoting PA that “feels good,” adolescent participants in the intervention condition did not increase time spent in MVPA to a greater extent than controls (Schneider et al., 2017). Additionally, the literature suggests there is stability in affective response to exercise in adolescents across time (e.g., a 4-month period) (Schneider et al., 2017). This stability indicates that some individuals are unlikely to have a positive affective response to PA, and therefore may be at increased risk of being less physically active despite being in environments set up for PA success (e.g., during a “fun” activity in a mandatory PE class). Interventions may need to take a novel approach to PA that does not seek to change affect and other internal experiences, but instead teaches skills for persisting in PA even when a positive affective experience is not present.

Acceptance and commitment therapy teaches participants to adopt an accepting stance towards internal experiences (affect, emotions, urges), rather than attempting to alter, suppress, or avoid them (Forman & Butryn, 2015; Hayes, Luoma, Bond, Masuda, & Lillis, 2006). Acceptance and commitment therapy-based interventions teach techniques to engage in valued behavior in the context of a wide range of internal experiences, thereby uncoupling internal experiences from behavior. In acceptance-based behavioral treatments (ABT), the focus on acceptance of internal experiences and engaging in values-consistent behavior is supplemented with self-monitoring and goal-setting, both of which are evidence-based approaches to modifying health behavior (Murray et al., 2017; Rose et al., 2017). Self-monitoring increases awareness of behavior by providing insight into times when one does not engage in valued behaviors, thus highlighting areas where acceptance is needed. Self-monitoring also produces data that are essential to see progress and to engage in goal-setting. There is evidence that self-monitoring and goal-setting can produce behavior change in adults; however, little research on self-monitoring with devices (i.e. Fitbit) has been conducted in adolescents (Olander et al., 2013; Ridgers, McNarry, & Mackintosh, 2016; Wang et al., 2012). Overall, self-monitoring and goal-setting are important components of ABT and should be included in interventions to increase awareness of the behavior, and thus increase opportunities for change.

ABT is proposed to be a well-matched treatment for PA specifically because it addresses the human drive to conserve energy (Forman & Butryn, 2015). This drive renders PA an uncomfortable, or less comfortable, experience as compared to sedentary activities which conserve more energy, and may negatively impact PA behavior even when the environment is set up for success. Research on adolescent PA suggests that some adolescents may find certain aspects of PA aversive, regardless of the environment (Schneider et al., 2017). Therefore, ABT approaches may be particularly helpful for those “reluctant” individuals whose affective experience does not naturally encourage PA, by addressing barriers to PA (internal experiences, such as the drive to conserve energy) that are not addressed by other interventions and are unlikely to change or dissipate (Schneider et al., 2017).

A small body of research provides preliminary support for an acceptance-based approach to PA promotion. One pilot trial of ABT to increase PA randomized young adult women to an educational workshop or an acceptance-based workshop (Butryn, Forman, Hoffman, Shaw, & Juarascio, 2011). The acceptance-based workshop taught specific skills to engage in willingness (ability to choose value-consistent behaviors even when such behaviors are accompanied by uncomfortable internal experiences), defusion (distancing oneself from ones’ internal experiences), and other acceptance-based skills through experiential exercises. Participants also identified, clarified, and connected values (ideas, principles, and domains in life that are the most important and personal) to PA. Participants in the acceptance-based intervention increased their PA, as objectively measured by visits to the gym, significantly more than those in the educational workshop (Butryn et al., 2011). In another randomized pilot study with young adult females, participants engaged in a high-intensity constant work rate cycle test, and were then randomized to either a single acceptance-based session or a single behavioral goal-setting session, and subsequently repeated the cycle test (Ivanova, Jensen, Cassoff, Gu, & Knäuper, 2015). Participants who received the acceptance-based session increased their second cycle test time by 15%, while participants in the goal-setting session decreased their time by 8%. While both of these studies were short-term, the results suggest ABT holds promise for increasing PA over and above standard education or standard behavioral interventions.

In sum, while ABT has been tested for increasing adult PA, no research that we are aware of has examined its use in adolescent populations. Acceptance-based approaches in general may be appropriate for adolescents because of their use of metaphors, experiential activities, and encouragement of personal learning, all of which may be well-suited for adolescents, who are less literal than adults and who seek out increasing independence (Hadlandsmyth, White, Nesin, & Greco, 2013; O’Brien, Larson, & Murrell, 2008; Swain, Hancock, Dixon, & Bowman, 2015). Given the emerging evidence supporting ABT for promoting adult PA, and the theoretical foundation for utilizing acceptance-based approaches with adolescents, there is clear rationale for testing an ABT intervention for increasing adolescent PA. Self-monitoring, potentially through a device such as a Fitbit, is an important aspect of an ABT intervention. However self-monitoring alone may facilitate behavior change. To isolate the ABT intervention, use of self-monitoring needs to be consistent across conditions.

Additionally, schools are the recommended setting in which to deliver PA interventions to adolescents, given the amount of time adolescents spend in school and the many adolescents that can be reached through school interventions (Committee on Physical Activity and Physical Education in the School Environment et al., 2013; National Heart, Lung, and Blood Institute, 2011). School nurses and other school health officials are key influencers of school health, and are well-equipped to deliver interventions around healthy eating and physical activity (NASN, 2014; Naylor & McKay, 2009; Schroeder, Travers, & Smaldone, 2016). Previous studies have had difficulty changing the prevalence rate of adolescents with low activity, and thus interventions that specifically target the adolescents with low activity are needed. Therefore, this study was designed to examine the feasibility and acceptability of a school-based ABT intervention for increasing PA in adolescents with low activity, and to explore treatment outcomes (i.e., physical fitness and MVPA) against a self-monitoring only group.

Methods

Recruitment

The study was conducted from September 2016 to June 2017 within an ethnically diverse public middle school in Southern California. Eighty-five students were screened using Fitbit Zips (Fitbit, San Francisco, CA), worn for 7 days, to identify students engaging in fewer than 60 minutes per day (on average) of MVPA. All 85 students screened were eligible. Students were then invited to volunteer for the pilot study via oral presentations and flyers. Interested students and a parent/guardian then met in person with study staff to have other eligibility criteria assessed. Parents and students verified that the student did not have asthma and was able to exercise without any restrictions and provided signed assent and consent. The first 20 students who presented were all eligible. The sample size was pre-determined as 20 due resource constraints (i.e., the availability of 20 Fitbit Flex 2 activity monitors). The study participants were all age 12 (7^{th} grade), and represented diverse ethnic backgrounds (55% Latino, 25% non-Latino White, and 20% Other; baseline characteristics can be found in Table 1 and 2). Statistical comparisons were not made between groups at baseline owing to small sample sizes, but groups were fairly similar on several measures. Notable differences include the self-monitoring only group engaging in approximately 7 additional minutes of MVPA as compared to the ABT group.

Procedures

Assessments and Group Allocation—All study procedures were reviewed and approved by an Institutional Review Board and the local school district research review committee. All study assessments took place on the middle school campus in a classroom/laboratory easily accessible to student during PE class periods. Each participant visited the converted classroom in the PE building two times both in the fall (pre-intervention) and spring (post-intervention), with approximately 2 weeks between each visit. Assessments included the following: (visit 1) height, weight, body composition, and cardiorespiratory fitness, followed by 1 week of activity monitoring with the ActiGraph activity monitor (visit 2) preferred-intensity task. The preferred-intensity task was conducted to establish a work rate intensity that “felt good” to the participant for the intervention sessions. Participants exercised for 30 minutes on a stationary cycle, starting at a work rate of 20% of their peak VO_2, with an option to increase or decrease resistance every 3 minutes. This is a previously established procedure with good test-retest and validity data (full procedure described elsewhere (Schneider, 2014). After completing the pre-intervention assessments, all participants were given a Fitbit Flex 2 and were allocated to one of two groups for a 12-week period: (1) weekly sessions consisting of acceptance-based behavioral counseling combined with preferred-intensity exercise for 30 minutes; or (2) self-monitoring only (Fitbit wear only). Participants were not randomized; rather, participants were allocated to condition based on students' class schedules.

ABT Intervention—Participants in the intervention group were collected from their PE class once a week for 12 weeks by research staff and brought to the converted classroom. Over the 12 weeks, 10 sessions were delivered. This allowed for flexibility with scheduling; extra sessions were used to make up missed counseling sessions, or, if make-ups were not needed, to allow the student to exercise for 30 minutes on a stationary cycle. The starting work rate for each student was determined by the highest work rate that the participant self-selected during the preferred-intensity task (described above). Participants were able to request a reduction in the work rate at any time during the session.

The intervention was conducted primarily by the Project Coordinator, who had a Bachelor's degree in Public Health, and had completed a 2-day training by graduate-level clinical psychology students with prior experience in ABT for PA and acceptance-based interventions. A few counseling sessions were conducted by the Principal Investigator of the study and supervised undergraduate research assistants, all of whom had also attended the training. Each session was guided by a detailed intervention script (written by a Ph.D.-level expert in ABT for PA, with input and editing by the intervention team to ensure that the language was appropriate for adolescents). Each session addressed behavioral and acceptance-based skills for PA engagement (Table 3). To promote student engagement and provide treatment appropriate for the age group, during the counseling sessions, sessions were enhanced with visual aids (e.g., a simplified map of the United States with a cross-country route illustrated to represent the difference between goals and values) and youth-friendly examples (e.g., discussions of competing demands from homework and computer gaming). As mentioned previously students completed the sessions on an exercise bike. This increased the opportunities for experiential activities, which are integral part of ABT and also helped to keep the adolescents engaged. Additionally in the later portion of the sessions several behavioral skills were taught to foster independence in the adolescents. At the beginning of each session, the interventionist set the agenda and structured the session as follows: check-in on previous goals, discussion of acceptance-based strategy, and goal-setting for the following week (informed by prior weeks' Fitbit data).

Measures

Acceptability of the intervention—Intervention participants were interviewed one-on-one by the interventionist, who took careful notes for further analysis. Participants were asked about the following at mid- and post-intervention: benefits and changes experienced, intervention likes and dislikes, and their experience of specific intervention components including Fitbit wear and Fitbit data review.

Feasibility of the intervention—Feasibility was assessed by tracking recruitment, retention, and engagement, as described in Table 4.

Body mass index (BMI) percentile—BMI percentile was obtained pre- and post-intervention by measuring height (stadiometer; PE-AIM-101, Perspective Enterprises, Portage, MI) and weight (scale; Seca 869, Chino, CA), and was computed according to the normative gender-specific values provided by the Centers for Disease Control and Prevention (Centers for Disease Control and Prevention, 2012).

Body composition (Percent body fat)—Triceps and calf measurements were obtained at pre- and post-intervention using skinfold calipers (Lange skinfold, Beta Technology Incorporated, Santa Cruz, CA) according to the Lange Skinfold Calipers Operative Manual. Percent body fat was computed using the Slaughter-Lohman children skinfold formula (http://www.skyndex.com/resources/Slaughter-Lohman-Children-Skinfold-Formula.html).

Waist circumference—Abdominal (waist) circumference was obtained at pre- and post-intervention with a tape measure (Gulick II Plus; County Technology Inc., Gays Mills, WI) according to published instructions (http://www.myhealthywaist.org/fileadmin/pdf/WCMG-Healthcare_Professional.pdf).

Cardiorespiratory fitness—Students completed a graded exercise test on a stationary cycle at both pre- and post-intervention (Whipp, Davis, Torres, & Wasserman, 1981). Gas exchange was measured breath-to-breath (ventilation, oxygen uptake, and carbon dioxide output) and was viewed online and analyzed using a Sensor Medics® metabolic system (Yorba Linda, CA) to determine peak VO_2.

Physical Activity—Two measures of PA (Fitbit and accelerometer) were included. The accelerometer is a standardized research tool widely used to assess activity in intervention studies, and therefore was included to model the rigor of a full-scale trial. However, there are real limits to basing an individual's usual level of activity on a single snapshot of seven days, and therefore the Fitbit was also included as a continuous measure of PA behavior over time (Wright, Hall Brown, Collier, & Sandberg, 2017).

Fitbit Flex 2 (Steps, MVPA): The Fitbit Flex 2 is a consumer-oriented device held by a wristband, is water-resistant, and can be worn continuously. All participants were given a Fitbit Flex 2 after the pre-intervention assessments and were instructed to wear the Fitbit Flex 2 every day for 12 weeks. Students were given charges for home-use, and given instructions for how to check the device's battery. Web-based Fitbit accounts were established for each student and managed by study personnel; students did not have access to their own accounts and were not given the password to view their data online. All participants were allowed to keep the Fitbit Flex 2 at the conclusion of the study as compensation. Steps and minutes of MVPA per day were downloaded from each Fitbit account and compiled for data analyses.

ActiGraph (MVPA): The ActiGraph activity monitor (model GT3x, ActiGraph, Pensacola, FL, USA) is a widely used, well-validated, research-grade, tri-axial accelerometer that is attached to a belt (Lee, Kim, & Welk, 2014; Santos-Lozano et al., 2013). The device is positioned on the non-dominant hip, has to be taken off for sleep, and is not water-resistant. Participants were instructed to wear the accelerometer for 7 days pre- and post-intervention period; data were considered valid if the device showed wear for a minimum of 4 days (i.e., at least 8 valid hours per day, with a valid hour including fewer than 30 consecutive minutes with zero activity), including at least one weekend day. The average time spent daily in MVPA was computed using the Freedson equation (Freedson, Melanson, & Sirard, 1998).

Data Analysis

To assess acceptability the notes from the interview were transcribed, and these notes were analyzed for themes using ATLAS.ti qualitative analysis software, 7.1 (Scientific Software Development, 2017). Data were coded by three independent coders, and minimal differences in coding were resolved through discussion. SPSS 24 (Descriptives) and R 2.12 (Fitbit analyses) were used for all other analyses (R Core Team, 2013). Missing data were deleted listwise. Data from all participants who completed a baseline assessment was included owing to the small sample size. The participants who were not included in the post-intervention data were not different at baseline from other participants, as evaluated by inspection of the raw data. Multivariate linear mixed effect modeling was used to evaluate the 12-week trend of Fitbit averaged daily steps and Fitbit MVPA (i.e., average daily steps and MVPA for each week) with adjustment for gender. Random effects for each participant were included in the model to account for repeated measures correlation within each student. Effect sizes (Cohen's *d*) were computed for physiological measurements and accelerometer-measured PA (Cohen, 1992). Tests examining statistically significant changes were not performed owing to the small sample size.

Results

Participant Characteristics

Table 1 and 2 provide pre-intervention participant characteristics. Figure 1 shows a CONSORT style depiction of the reasons for attrition during the study or exclusion from analyses.

Feasibility

Feasibility measurements and results are summarized in Table 4. Recruitment was conducted on a rolling basis to accommodate the assessment schedule, with the goal of recruiting all 20 study participants and completing pre-intervention assessments over 10 weeks. This goal was met; an average of 2 students per week were successfully recruited and completed all assessments. Retention for the entirety of the study across conditions was high (85%); three participants were excluded due to injury or ActiGraph non-compliance. The most problematic aspect of the intervention implementation was the number of times that study participants showed up to an intervention session either without their Fitbit or with a Fibit with a dead battery. Table 4 shows that students failed to present to a session with a working Fitbit approximately 17.5% of the time (2.1 out of 12 weeks), thus precluding a discussion about activity monitor data for that week. Because data were often still available through later syncing, the total amount of data available for research purposes was far greater (i.e., 90% of days for the intervention group, 74% of days for the comparison group). In addition, over the course of the study three students lost the Fitbit. Two were replaced, but the third was lost late in the study and was not replaced.

Regarding the ABT intervention implementation, there was a high rate of rescheduling for the intervention sessions, with each student rescheduled an average of 5.4 times over the course of the intervention. However, these schedule changes were easy to accommodate either by moving the assessment to another day within the same week or by utilizing one of the two extra weeks built into the intervention schedule to complete a make-up assessment. Consequently, 100% of ABT participants completed all of the behavioral counseling sessions.

Acceptability

Table 5 summarizes the qualitative data collected from participants. Overall, participants who received the ABT intervention (n=9) found it acceptable and reported that they noticed at least one physical improvement because of being in the intervention. A few students disliked missing specific preferred activities during the PE period and/or completing the cardiorespiratory fitness test at the assessments. However overall, evaluations of the experience were overwhelmingly positive, especially regarding the incorporation of the Fitbit into the intervention.

When asked specifically about strategies used to increase PA, four out of the nine participants reported using an acceptance-based skill. Specifically, one student reported "changing 'but' to 'and' at home" (a reference to a strategy for acceptance of thoughts that may deter PA, and practicing willingness to engage in PA); another student reported "hold[ing] myself accountable to be more active"; a third student reported using "values on some days" (i.e., connecting to values relevant to being physically active as motivation for engaging in exercise); and a fourth student specifically noted that she "kept practicing willingness and accepting uncomfortable thoughts."

Physical Activity Results

Fitbit Flex 2 weekly data—Average daily steps and average minutes-per-day of MVPA increased in the intervention group over time. On average, each week, students in the intervention group increased their daily step count by 125 steps ($p = 0.0013$), such that by 12 weeks daily activity was approximately 1,200 steps per day higher than at baseline. A trend was not detected in the self-monitoring only group due to the high variation in steps within this group (slope = 76.58; $p = 0.27$). Similarly, intervention students increased their minutes-per-day of MVPA by 0.99 each week ($p = 0.0009$), such that by 12 weeks, daily MVPA was 12 min/day higher than at baseline. There was no corresponding increase in MVPA among the comparison group (slope = 0.79; $p = 0.16$).

ActiGraph Accelerometer pre-post data—As measured by the accelerometer, activity increased in both the intervention and self-monitoring only groups. The intervention group increased accelerometer measured minutes in MVPA from pre- to post-intervention by 7.25 min/day, and the self-monitoring only group increased by 11.99 min/day.

Physiological Results—Post-intervention values of the physiological measurements can be seen in Table 6. The intervention group increased both their relative and absolute VO2 max, while the self-monitoring only group remained stable or decreased, yielding medium to larger effect sizes (Cohen, 1992). The intervention group showed essentially no change over time in percent body fat, whereas the self-monitoring only group increased slightly, and this difference yielded a medium to large effect size. The intervention group demonstrated a decrease in BMI and BMI percentile as compared to the self-monitoring only group which showed increases in these measures, although the effect sizes were in the small to medium range. Waist circumference also increased more among the self-monitoring only group, yielding a small effect size.

Discussion

The present study was the first to our knowledge to examine the feasibility, acceptability, and treatment outcomes of an ABT, school-based intervention for adolescent PA. Schools are an ideal place to target PA because of the time students spend in school, availability of healthcare providers trained to promote healthy behaviors, and low- to no-cost to the students to access the intervention. The intervention was found to be feasible. Owing to the location of the study and the flexibility of the interventionists, none of the participants missed any intervention sessions. While each student had to reschedule sessions several times, if a student was not available for the session the interventionist chose a different student for the open time. This flexibility increased efficiency in clinician time, which is an important factor to consider for nurses and physical education teachers that may implement similar interventions. This finding demonstrates that incorporating scheduling flexibility into a school-based study can strengthen attendance and feasibility. Despite some technological issues with the self-monitoring devices, which occasionally resulted in students presenting to the counseling sessions with no data for the prior week, each student in the intervention condition still engaged in guided goal-setting at a majority of the sessions. As device battery life improves, these technological issues are likely to become a trivial concern. Of note, in terms of study-wide device compliance, the number of wear days of the Fitbit in the intervention group was higher than in the control group. This may have contributed to some bias in the data, but overall does suggest that the intervention may have provided additional accountability to remember to wear and charge the Fitbit.

Participants in the ABT condition described the intervention as acceptable and enjoyable, and were able to detail several benefits of participating, such as being reminded of their goals by the Fitbit and learning from reviewing their data with the interventionist. Some participants were able to articulate acceptance-based skills that they used, including specifically naming acceptance, willingness, and values, and noting the context in which they used the skill to engage PA despite uncomfortable internal experiences. However, not all participants were able to describe the usage of acceptance-based skills. It is possible that some participants understood the ideas and principles from the intervention, but were unable to explicitly verbalize specific skills. All efforts were made to adapt the intervention to the age group (i.e. calling defusion “separating from ‘sticky thoughts’”); however, some students may not have retained the terms from the intervention sessions. Participants may have understood the concepts of the ABT intervention, but without measurement of acceptance-based components it is uncertain whether the acceptance-based skills themselves can be credited with increasing adolescents’ activity levels.

There were mixed results from the PA measurements. In regards to the Fitbit data, the intervention group significantly increased over time, whereas the control group showed no such pattern. These results should be interpreted cautiously, as between-group comparisons were not conducted, however the data are consistent with a positive impact of the intervention on physical activity. These results differed from the accelerometer data, which showed that activity in both groups increased over time. This discrepancy could be due to the frequency of measurement, as the Fitbit data were collected weekly throughout the study and depict a trend in behavior over time, whereas the accelerometer was used to assess activity only for one week at pre-intervention and one week at post-intervention. Additionally, previous studies have noted that while most tracking devices correlate and are more accurate than self-report, there can be discrepancies when comparing results from different devices (Brewer, Swanson, & Ortiz, 2017; Imboden, Nelson, Kaminsky, & Montoye, 2017). While the Fitbit has not undergone as rigorous validation as the accelerometer, it does provide a unique opportunity to see the trajectory of change over time. These mixed results suggest future research is needed to fully assess and understand how ABT interventions may affect trends in PA over time, as compared to how they may affect net change in PA pre- to post-intervention.

The PA data from the Fitbit and accelerometer are mixed, however the cardiovascular and physiological results cumulatively support that the intervention group benefitted from an increase in PA over the course of the study. Although we were precluded from establishing a statistical effect of the intervention on these outcomes because of the small sample size, the pattern of these results offers preliminary evidence of benefits from the ABT intervention. Effect sizes demonstrated that the ABT group increased their mean cardiovascular fitness as compared to the self-monitoring only group who remained stable or decreased on both measurements of cardiovascular fitness. Effect sizes also demonstrated that the ABT group remained stable on measurements of their BMI, BMI percentile, and body fat percentile, while the self-monitoring only group increased in those measurements. These results suggest that the intervention may have facilitated body mass and fat maintenance, theoretically by facilitating an increase in PA over time. Most other self-monitoring intervention studies of similar length have not measured this range of cardiovascular and physiological data, and those that have included BMI do not show a change in BMI nor the proportion of physically active students in this short period of time (Mendoza et al., 2017; Ruotsalainen, Kyngäs, Tammelin, Heikkinen, & Kääriäinen, 2015; Shapiro et al., 2008). Therefore, this study demonstrates that this ABT intervention may hold more promise in the short-term for improving fitness among low activity adolescents than previously tested interventions, although replication with larger samples that allow for formal statistical testing is needed.

Limitations and Future Directions

Several limitations of this study should be noted. The study was conducted as a pilot study, and therefore the small sample size, lack of randomization, and lack of long-term follow-up are all limitations that effect the strength and generalizability of results. The sample was also all 12 years old, and this limits generalizability to older adolescents who may respond differently to interventions. All of the students enrolled had low activity. Potentially students with higher levels of activity have less negative internal experiences, and thus ABT interventions may not be generalizable to such samples. The usage of the Fitbit Flex 2 as the PA measurement over time may also represent a limitation. Fitbit results do generally correlate with accelerometer-measured PA in adults and adolescents; however, most studies have found that the Fitbit overestimates PA as compared to accelerometer and direct observation (Schneider & Chau, 2016; Sushames, Edwards, Thompson, McDermott, & Gebel, 2016; Voss, Gardner, Dean, & Harris, 2017). Additionally, the Fitbit Flex model used in this study has not been fully validated in adolescents, although previous models have been (Hamari et al., 2017; Schneider & Chau, 2016). An additional limitation of the Fitbit Flex 2 is the length of charge; several participants charged their device and subsequently left it on the charger, or forgot to charge it at all, leading to missing data. Future iterations should either utilize a device with longer battery life or develop a protocol to specifically help adolescents charge and remember to wear their devices. Such protocols would also reduce future study costs in resource-limited settings.

Another limitation is the lack of fidelity measurements for the intervention. While the intervention manual was structured and scripted, sessions were not recorded and neither fidelity ratings of the interventionists nor skills comprehension of the adolescents were measured. Additionally, while the interventionists and manual teams worked in consort, there was no specific regular supervision for the interventionists. The lack of these measurements and supervision are limitations, particularly given the low level of acceptance-based training of the interventionists and prior research demonstrating that the background level of interventionists providing acceptance-based treatment predicted outcomes in a weight loss study (Forman et al., 2013). However, since this study does show promising results for the acceptance-based behavioral intervention despite the low-level of training of the interventionist, it does suggest that this intervention could be implemented by a wide range of school employees. While this study was not tested specifically with school nurses at this pilot stage, nurses would be the ideal interventionists as key influencers of school health, their connection to students and families, and their ongoing presence in the school (NASN, 2014; Schroeder, Travers, & Smaldone, 2016). Future studies should consider testing this intervention in other formats to increase feasibility in a school setting, such as with nurses or in a group format.

Future directions include a larger, full-scale randomized controlled trial that addresses the limitations above and compares an ABT intervention to a behavioral intervention. Inclusion of activity monitoring devices that have established reliability and validity in such a study would also strengthen conclusions. Future studies should include process measures of acceptance-based skills to ensure the changes seen in PA are due to the intervention components. Future studies should also include a focus on dissemination to ensure a range of school employees can implement the acceptance-based behavioral techniques.

Conclusions

Adolescents with low PA are at high risk for remaining inactive, and chronic low PA has many negative side effects. This study recruited only adolescents with low PA who were then assigned to receive an acceptance-based intervention or use of a self-monitoring device only. Results suggested the study was feasible and the intervention was generally acceptable to the participants. The intervention group showed a significant increase of 1,200 steps per day and 12 minutes of MVPA per day over the course of the study, compared to the self-monitoring only group which did not show an increase over time. The intervention group also showed positive changes in cardiovascular and physiological measures as compared to the self-monitoring only group. Given the results of this study, influencers of school health (nurses, physical education teachers) are encouraged to be aware of individual factors (such as internal experiences) that may be a barrier to PA engagement and help those students use additional acceptance- and/or behavioral strategies to overcome them. The National Association of School Nurses has stated that "[s]chool nurses are in the prime position to influence the behavior of children and adolescents in developing good decision-making skills related to nutrition and physical activity to develop and achieve healthy lifestyles" (NASN, 2014). If proven to be effective, this approach might offer school nurses a tool for promoting physical activity among overweight and/or sedentary students. Overall this study indicated that acceptance-based approaches have potential to increase activity in students that previously had been inactive, and results suggest future efficacy testing of an ABT intervention for PA promotion in adolescents is warranted.

Acknowledgments

The author(s) disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: The project was supported by the National Institutes of Diabetes and Digestive and Kidney Diseases, National Institutes of Health, through Grant RO1 DK088800, and by the National Center for Research Resources and the National Center for Advancing Translational Sciences, National Institutes of Health, through Grant UL1 TR000153 and UL TR001414.

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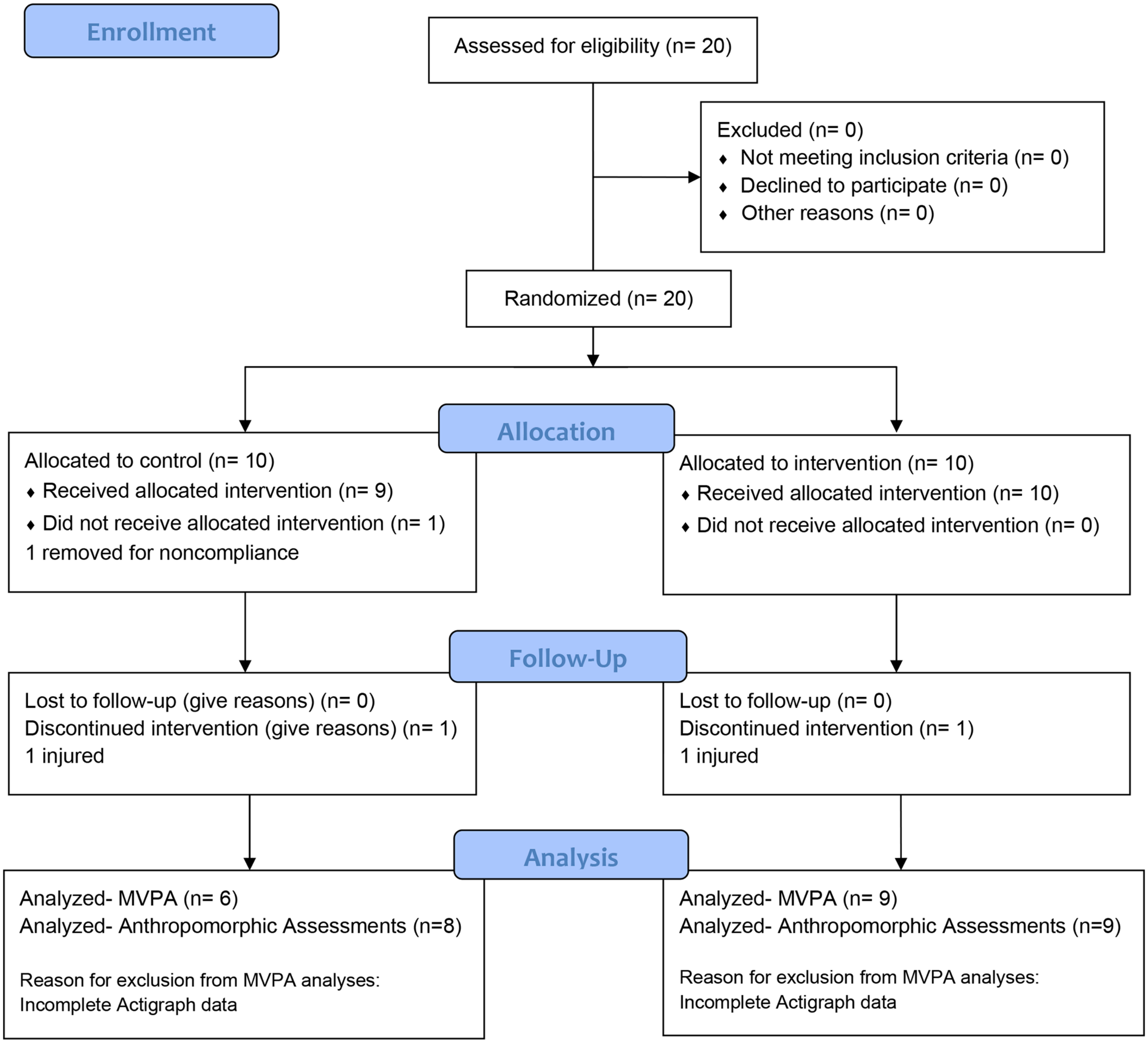

Figure 1.
CONSORT flow. CONSORT: Consolidated Standards of Reporting Trials.

Table 1.

Pre-intervention Characteristics

	All	Boys	Girls
Ethnicity			
Latino, N (%)	11 (55)	4 (50)	7 (58.3)
Non-Hispanic White, N (%)	5 (25)	3 (37.5)	2 (16.7)
Other, N (%)	4 (20)	1 (12.5)	3 (25)
Age (yrs), M (SD)	12.00 (0.00)	12.00 (0.00)	12.00 (0.00)
VO2peak (L/min), M (SD)	1.99 (0.45)	2.24 (0.50)	1.82 (0.35)
VO2peak (mL/kg/min), M (SD)	37.74 (7.17)	41.70 (7.98)	35.10 (5.42)
BMI, M (SD)	21.74 (3.64)	22.40 (4.48)	21.30 (3.09)
BMI Percentile, M (SD)	71.95 (28.96)	74.38 (32.31)	70.33 (27.87)
% Body Fat, M (SD)	21.54 (6.41)	22.10 (9.41)	21.17 (3.78)
Waist Circumference (cm), M (SD)	76.10 (11.31)	79.05 (14.06)	74.14 (9.20)
MVPA ActiGraph (min), M (SD)	37.38 (13.85)[1]	43.02 (16.02)[2]	34.09 (11.91)
Total number in each group	20	8	12

[1] n=19

[2] n=7

Table 2

Pre-intervention Measures

	Intervention M (SD)	Self-monitoring only M (SD)
VO2peak (L/min)	2.00 (0.61)	1.97 (0.25)
VO2peak (ml/kg/min)	34.30 (5.19)	41.18 (7.45)
BMI	22.76 (4.03)	20.72 (3.06)
BMI Percentile	76.10 (28.62)	67.80 (30.22)
Percent Body Fat	24.18 (6.31)	18.90 (5.61)
Waist Circumference (cm)	78.28 (13.78)	73.60 (8.24)
MVPA Accelerometer (min per day)	34.01 (15.57)	41.13 (11.36)[1]
Totals (*N*=20)	10	10

[1]n=9

Table 3.

Weekly Topics in the Counseling Sessions

Session	Topic
Session 1	Introduction to study and rapport building
Session 2	Physical activity enjoyment and internal experiences during physical activity
Session 3	Introduction of “Control what you can and accept what you cannot” framework
Session 4	Values and introduction to “willingness”
Session 5	Specific willingness skills
Session 6	Willingness review and “defusion”
Session 7	Habits and accountability
Session 8	Goal setting principles
Session 9	Relapse prevention (values review, long-term exercise goals)
Session 10	Review and ending well

Table 4.

Feasibility Outcomes

Outcome	Method of Assessment	Study Result
Recruitment	Average number of participants enrolled per week of recruitment	4 participants
	Participants not interested or ineligible after screening and invitation to participate	0%
Study-wide Compliance	Participants who completed all assessments	85%[a]
	Average number of valid weeks of Fitbit data (maximum 12 weeks)	9.5 weeks[b] *SD*=3.23
	Average number of days of valid Fitbit wear (out of a maximum of 84)	62.5 (control) *SD*=17.40 78.1 (intervention) *SD*=8.64
Intervention Engagement	Average number of weeks that students presented to session with no Fitbit or a dead Fitbit	2.1 *SD*= 1.26
	Average number of intervention sessions completed by each student (maximum of 10)	10 (*SD*=0)
	Average number of times intervention sessions rescheduled	5.4[c] *SD*=1.66

[a]Reasons for exclusion/drop-out: n=1 excluded for non-compliance with accelerometer at beginning of study; n=2 experienced minor injuries (not related to study activities) during the study period and could not participate in physical education sessions

[b]A valid week of Fitbit data was defined as 4 days with at least 500 steps.

[c]Reasons for rescheduling included: mandatory physical education fitness assessments, school field trip/assemblies, student absence from school

Table 5

Acceptability results

Query	Participant Response	n
What benefits did you notice from the intervention?	More energy	6
	Trying harder in PE class	5
	More focused	3
What did you dislike about the intervention?	Missing preferred PE activities	3
	Cardiorespiratory fitness test (part of study assessment)	3
What did you like about using the Fitbit?	Reviewing the Fitbit data with the interventionist weekly	4
	Fitbit was a helpful tool to remember PA goals	9
	Fitbit was comfortable to wear	6

Table 6

Post-Intervention Measures

	Intervention	Self-monitoring only	Effect size[a]
	M (SD)	M (SD)	
VO2peak (L/min)	2.12 (0.53)	1.97 (0.40)	0.52
VO2peak (ml/kg/min)	36.26 (4.16)	38.76 (2.35)	0.94
BMI	22.39 (3.84)	21.12 (3.35)	0.58
BMI Percentile	73.89 (26.56)	68.00 (33.07)	0.00
Percent Body Fat	24.53 (4.56)	21.39 (2.35)	0.77
Waist Circumference (cm)	81.54 (11.06)	77.43 (8.50)	0.07
MVPA Accelerometer (min per day)	41.26 (18.83)	53.12 (11.74)[2]	0.41
Totals (*N*=20)	9	8	

[1] n=9

[2] n=6

[a] Description of effect size calculation located in Statistical Analyses section.