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Can Dance Exergames Boost Physical Activity as a School-Based Intervention?

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Abstract

Background: Children need opportunities to have physical activity (PA). Using exergames could be a feasible and acceptable way to boost PA in middle schools. Our goal was to increase PA by 40 minutes per week and to determine how much time, if any, was spent in moderate-to-vigorous PA (MVPA).
Subjects and Methods: Eighty-four middle school youth were in a pilot study for 20 weeks: half in the Generation Fit (GenFit) intervention group and half in the control group. The GenFit group played the exergame for the first 10 weeks (Session 1), and the control group joined from 10 to 20 weeks (Session 2). The main outcome was exergaming time per student per week.
Results: Fifty-eight students completed the pilot after 26 youth at School C were excluded for administrative reasons. Of those remaining, 40 students at School A and 18 students at School B, the average age of the sample was 13.7 years (SD = 0.6), and average body mass index percentile was close to 70. During Session 1, the average dance time per child was 49 minutes per week, versus 54 minutes per week in Session 2. Mean body mass index percentile decreased by 5.6 for children who participated in GenFit, compared with 0.2 for children in the control group. At end point, accelerometers showed over half of the dance time was spent in MVPA. Qualitative data showed that most children found the exergame acceptable.
Conclusions: A dance exergame in middle schools offered opportunities for PA. About half of the exergame time was spent in MVPA. Exergames may be feasible and acceptable in middle schools to boost PA, and access could provide a way for schools to support the health of students.

Background

New approaches to counter the epidemic of pediatric obesity are urgently needed.[1] Although it is recommended that youth engage in 60 minutes of physical activity (PA) daily, studies show significant declines between the ages of 9 to 15 years,[2,3] with only 3 percent of children meeting vigorous PA goals.[4] Youth should be supported to engage in moderate-to-vigorous PA (MVPA) for cardiovascular health.[5] Therefore, it is important to offer children convenient places for such opportunities.

Because children spend many of their waking hours in school, it is a logical place to try to increase opportunities for PA.[6] Research suggests that school-based strategies to tame the obesity problem will likely include efforts from individuals other than classroom teachers, targeted approaches focused on middle or high schools, and reduction of inactivity.[6] School-based interventions have already demonstrated promise,[7–10] but such programs can challenge school budgets.

The lower cost of newer technologies creates an opportunity. Approaches using videogames for change behavior in children have recently garnered support.[11] In particular, exergames, or active videogames, which stimulate movement but do not require a large gym spaces or physical education (PE) teachers, could be used to provide motor breaks.[12,13] It is important to consider creative strategies to boost PA because too few children have daily PE.[14,15]

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Our study is registered at Clinicaltrials.gov with trial registration identifier NCT00424918.
This project is dedicated to Len Keilson, MD, who provided guidance to our team and is greatly missed by the research community in Maine.

Anecdotal reports of exergaming in school settings have been encouraging, but they have not been formally tested.[16]

Previously, exergames have demonstrated health benefits, including improved flow-mediated dilation,[17] and they have been shown to increase energy expenditure in youth.[18–21] Youth report enjoyment of exergames offered in afterschool settings.[22] It is critical that enjoyment is taken into account when designing interventions for youth because studies show that enjoyment of PA is important for sustained motivation and participation.[23] Studies have also linked fitness and educational attainment.[24]

The exergaming literature has demonstrated that both the environment and adult guidance are key elements in developing programs for children.[25] However, just providing exergames without changing the other contextual factors does not result in sustained PA changes.[26–28] Nonetheless, exergames are an attractive option for schools because of their engaging design features and relatively low cost and because they do not require constant adult supervision. However, no randomized trials of exergames incorporated into schools have been carried out; indeed, the feasibility of such an intervention is unknown. In order to determine the feasibility of incorporating exergames as an adjunct to PE classes, we initiated a pilot study in middle schools in several rural Maine communities. The primary aim of the project was to determine whether the peer-led intervention could boost PA by at least 40 minutes per week for each student.

Subjects and Methods

Participants

We selected schools from three schools participating in program called Take Time![29] We recruited school health coordinators, who agreed to be our liaison with student leaders, whom we called Groove Masters, for purposes of data collection. Two were health educators, and one was a school nurse. They helped us identify eligible students, locations, and times when exergames could be offered at their schools. At one school, an interested math teacher offered a place in a classroom for the exergame. In another, the health classroom was designated because large-screen TVs were set up on carts in that area, which was not heavily used and was near a sponsoring teacher's office. In a third school, the game setup was in a common area near a gym. We asked staff to guide students, but our intention was a peer-led activity, with Groove Masters taking the lead on the exergames data collection. Schools identified fax machines so Groove Masters could send results to our study staff on a weekly basis. We asked youth to engage in exergaming while they had "free" times, such as study hall (after completing work), before/after school, or at the lunch period. We did caution participants that the games should not interfere with educational activities, and Groove Masters could help by making the effort orderly and letting study staff know if troubles arose (on their weekly faxes).

Prior to the start of the study, one member of our team (A.E.M.) spoke to all of the students at the schools who wished to participate about the aims of the study and study design (reasons for using a control group) and how to keep careful logs. These were conducted in 30-minute sessions, with time for students to ask questions. Inclusion criteria were essentially the same as for PE (students had no health reasons to not participate). Children were excluded from participation if they were planning to move within 6 months or were unable to read materials in English. This research protocol was approved by the Institutional Review Board at the Maine Medical Center Research Institute. Informed consent of parents or guardians was obtained in writing, and youth assent was also obtained prior to participation. We also explained the research study to the principals, teachers, and PTA members as part of our multilevel informed consent process.

Subject measures

To obtain body mass index (BMI), study staff measured weight and height using a mechanical column scale and a wall-mounted stadiometer, while youth wore a light layer of clothing without shoes. Measurements were used for the gender- and race-specific norms, and BMI was calculated from Centers for Disease Control and Prevention charts (see www.cdc.gov/growthcharts).

Exploratory measures

We did not know if students would begin to exert less activity over time as they became more conditioned to the game and used less effort to score points. Therefore, we planned a limited study using accelerometers to test this at end point. Drawing names randomly from the 17 study completers at Week 20 from one school, we selected four to wear a hip-worn accelerometer to measure the intensity of the bouts of activity in real-time. They were asked to play any song they liked and dance with a friend. This became the basis of determining if subjects were engaged in the majority of exergame time above the cut points established for MVPA. We had four model GT1M ActiGraph (Fort Walton Beach, FL) accelerometers and decided to use published cutpoints derived from Evenson et al.[30] and set the accelerometers to measure 1-second epochs. We also identified biomarkers of health, which were measured using the portable CardioCheckPA blood analyzer (Polymer Technology Systems, Indianapolis, IN). The rationale for this was to obtain fasting glucose and lipid levels (to estimate the percentage of youth with risks for the metabolic syndrome in planning for future studies). We found 11 willing youth at the school closest to our medical center who pledged to fast after midnight the night before testing and who were open to reminder calls on the three nights before these measures. Study staff performed finger sticks for these tests, after which we provided them a nutritious breakfast. Because our overall goal was to test feasibility, we created exit surveys for both youth and teachers to gauge this part of our study and learn about ways we could improve our protocol in a larger study in the future.

Intervention

Our goal was to increase PA by 40 minutes per child per week by providing exergames. Each school was furnished two sets of Playstation®2 (Sony Corporation of America, New York, NY) hardware, the software "In the Groove" (Red Octane, Sunnyvale, CA), and two padded dance mats with an 8MB memory card. (No hand controllers were provided on purpose to discourage students from playing other games on these consoles.) The game is designed to be danced in rounds

of three songs totaling approximately 5 minutes for a round. Like with a jukebox, youth could pick their own songs from "In the Groove," with some having more complicated foot patterns or faster tempos to challenge the subjects over the semester. We encouraged all participants to set a goal of about 10 minutes per day on 4–5 school days per week.

In addition, we decided *a priori* that if youth wanted to "ghost" behind the dance pads (dance behind them but not on the dance mats that kept score), they could still document this time in the logs and it would "count" as time dancing. The reason for this was to allow more than two students to dance at a time and encourage social play.

We decided that the first half of the students would be the Generation Fit or "GenFit" intervention group, and the other would be the control group, who would sit out for the first half. For the second half of the study, we let all of the subjects participate, so this doubled the participation in the final weeks. During the second half of the study, we did not increase the number of Playstation2 setups or dance mats. We wanted to see if the first group would keep playing or if there would be any burnout or decreased interest over time. We provided charts and clipboards for students to log their minutes of dance time and our fax number for the several Groove Masters to get the total minutes to the study staff.

Assignment to condition

Subjects ($n=84$) were randomly assigned to the GenFit group or the control group. This randomization schedule was performed within the three schools to be sure all schools were balanced. We did not make any attempt to mask the condition from the other participants. Exergame times were recorded by ID number, and only those randomized to the GenFit condition were allowed to play for the first 10 weeks.

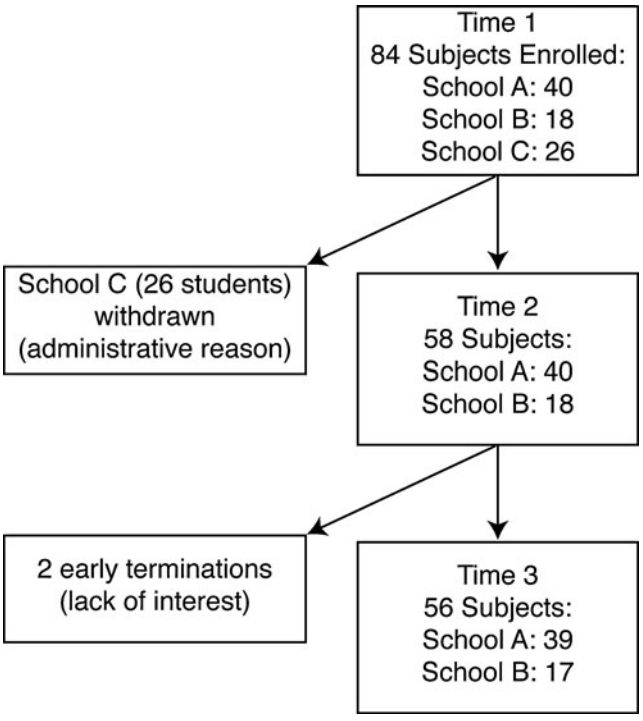

FIG. 1. Subject flow through the study.

Table 1. Demographic Characteristics of the Children Included in the Study ($N=58$) at Baseline

	Total sample (n=*58*)	*GenFit group* (n=*29*)	*Control group* (n=*29*)
Age (years)	13.7 (0.6)	13.7 (0.7)	13.8 (0.4)
BMI Percentile	69.5 (29.3)	72.9 (27.1)	66.3 (31.4)
Female (%)	29 (50.1)	16 (55.2)	13 (44.8)

BMI, body mass index; GenFit, Generation Fit.

During the second half of the study, all enrolled children could play the exergame and log their times. All study measures were performed longitudinally at three time points during a single second school semester (January–June).

Data management and analysis

Data from surveys were collected by study staff. All data were doubly entered in a Microsoft® (Redmond, WA) Access Database. Subsequently, data were imported for analysis in SAS version 9.2 software (SAS Institute, Cary, NC). Descriptive statistics were calculated using means, standard deviations, and 95 percent confidence intervals for continuous variables and frequency and percentage for categorical variables.

Results

The study began with 84 youth in three schools. During this protocol, one school (with 26 subjects) was excluded because that semester they obtained a significant Carol White Physical Education Program Grant. We were concerned that the additional resources from that grant could introduce bias into our study, which also equipped that school with exergaming equipment. Therefore, only data from the remaining two schools are included in this report. The flow through the study, including loss to follow-up, is presented in Figure 1.

The characteristics of the sample of the 58 children included in this report are presented in Table 1. In brief, the average age of the sample was 13.7 years (SD=0.6), approximately half of the participants were female, and the average BMI percentile was close to 70 (within a healthy weight range).

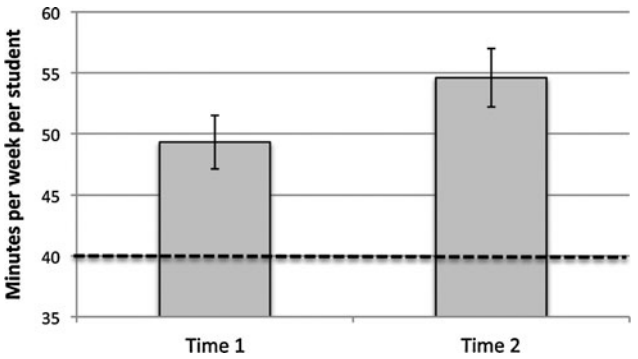

FIG. 2. Mean dance times with 95 percent confidence intervals for the first versus the second 10-week block.

Table 2. Body Mass Index Percentile Descriptive Statistics

	Body mass index percentile					
	Time 1		*Time 2*		*Time 3*	
	GenFit	*Control*	*GenFit*	*Control*	*GenFit*	*Control*
School A	79.6 (21.6)	79.1 (20.1)	78.8 (24.8)	78.5 (18.8)	77.4 (25.2)	77.8 (18.1)
School B	55.6 (32.1)	31.3 (34.2)	57.6 (32.7)	43.2 (36.4)	48.1 (36.4)	31.9 (28.8)

Data are mean (SD) values.
GenFit, Generation Fit.

Students in the intervention group self-reported their minutes per week spent using the exergame. In Session 1, in the GenFit intervention group, 68.1 percent of students used the game for at least 40 minutes per week, and during Session 2, 71.9 percent used the game for at least 40 minutes per week. Average exergame times are presented in Figure 2.

We also wanted to determine if more equipment was needed or if the intervention group would decrease interest in the exergame over time. The finding that minutes per week per student rose in the second half of the study suggests that youth remained engaged throughout the intervention and equipment was adequate.

Mean BMI percentile changed by 5.6 percentage points for children who participated in the intervention condition, compared with 0.2 percentage points for children in the control group, although this relationship appears to be moderated by school (Table 2 and Figs. 3 and 4).

Results from the blood tests are presented in Table 3 for descriptive purposes. We had only 11 youth from School B who were willing to fast before school, and of these, we found seven children who had abnormal lab values. Two had triglycerides over 110 mg/dL, and five had high-density lipoprotein under 40 mg/dL. However, no one child met all criteria for metabolic syndrome, according to youth criteria.[31] (We decided to alert the child's pediatrician if the lab values we obtained were out of range for our instrument, and the school nurse assisted us in giving families this information.)

Accelerometers showed that during bouts of dance, on average, youth obtained 2.1 minutes (SD = 0.6) of light PA, 2.8 minutes (SD = 0.5) of MVPA, and 1.6 minutes (SD = 0.3) of vigorous PA while dancing one full exergame cycle of three songs at the study end point.

Qualitative data were obtained to gain insight about exergaming and this peer-led study. Most children found the exergame acceptable, according to our satisfaction surveys. All open-ended questions were read and tabulated, and themes were analyzed. The majority of youth indicated that they enjoyed dancing during the school day, especially with friends. However, several told us they would have liked "better songs." Most kids found dancing in school "cool," "fun," and "great," and a way to let "the extra energy out," and most looked forward to exergaming. On the downside, a few were embarrassed or nervous or felt awkward doing exergame in the school setting, more so at the beginning of the study. Responses to whether the kids noticed any change in themselves included the following: "I am more energetic," "I pay attention in class more," "I am stronger as a person and I have a better personality," and "I have lost weight and became more active." Teachers provided feedback that they enjoyed their participation, finding it was not a significant burden to them. They relied on the youth Groove Masters to fax in the logs and found them responsible (few prompts were needed). We had only one school that reported a broken dance mat, which we replaced for them in a few days.

Discussion

This pilot study demonstrated that exergaming in the middle school boosted PA during school day, and overall results supported this as a feasible approach. Youth reported that they enjoyed the activity, and teachers found the exergaming acceptable. We received no complaints that the study was disruptive in schools. We found that youth handled the game equipment easily; the majority also told us they have Playstation2 consoles at home. Although the majority liked the activity, some let us know that the dancing was embarrassing, and, in retrospect, we could have done more to stress the tutorials, which have slower songs and encouraging prompts within the game.

We gave all families access to our phone numbers, e-mail addresses, and a study pager, but we did not receive any complaints in the 20 weeks of the pilot, which was encouraging. The total equipment cost was approximately $250 per

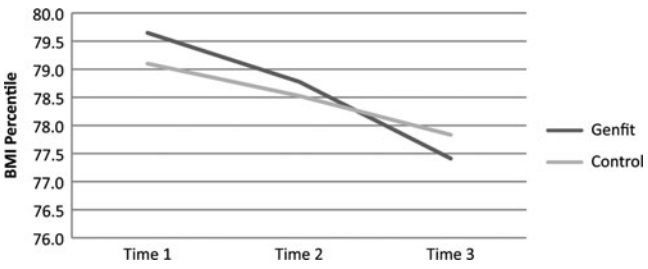

FIG. 3. Body mass index (BMI) percentiles for School A. Genfit, Generation Fit.

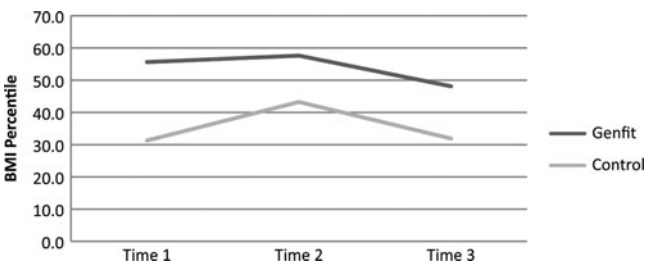

FIG. 4. Body mass index (BMI) percentiles for School B. Genfit, Generation Fit.

Table 3. Blood Chemistry Descriptive Statistics for School B

	Time 1		*Time 2*		*Time 3*	
	GenFit	*Control*	*GenFit*	*Control*	*GenFit*	*Control*
Total cholesterol (mg/dL)	133.0 (43.3)	152.8 (24.9)	135.0 (19.6)	132.2 (31.3)	139.0 (26.2)	158.5 (26.1)
HDL (mg/dL)	41.7 (19.9)	36.1 (21.1)	43.8 (18.0)	34.0 (15.4)	47.4 (23.1)	42.5 (16.6)
LDL (mg/dL)	81.0 (23.8)	95.3 (14.6)	81.3 (8.6)	76.4 (32.4)	81.5 (11.6)	103.8 (27.5)
LDL/HDL ratio	2.1 (0.4)	3.4 (2.0)	2.2 (1.1)	2.7 (1.5)	2.2 (1.3)	3.0 (1.9)
TG (mg/dL)	51.7 (2.9)	107.3 (48.2)	50.0 (0.0)	108.7 (115.3)	50.6 (1.3)	60.8 (18.6)

Data are mean (SD) values. Variable sample sizes were available for each outcome ($n = 3–5$).
GenFit, Generation Fit; HDL, high-density lipoprotein; LDL, low-density lipoprotein; TG, triglycerides.

setup at each school, and none was reported stolen during the study (we did not provide any locks or ways of securing the devices). The games did seem to "play themselves" and were a dependable way to get activity bouts during the school day.

There were differences in the outcomes between schools. We were disappointed that one school was not included in our final analysis and in future studies will take into account other projects pending that may impact our study aims. We learned doing this study that in Maine middle schools, each child is scheduled for only about 30 days of PE for about an hour each session in a school year. Taking this into consideration, by adding exergaming in our pilot study, where over two-thirds of study subjects had an additional 40 minutes per week over 10 or 20 weeks, this type of exergame could make an impact in that setting and could have downstream health benefits.

Our study was not designed to change BMI, but we did observe a trend of participants' BMI trending toward the 50th percentile and not toward obesity.

There are several important limitations in this small study. Our study population was not ethnically diverse, reflecting the entire state's racial makeup. Our convenience sample consisted of schools involved in health promotion programs, which may have had more enthusiastic staff than is found in typical middle schools. Although we observed youth informally coaching each other during exergaming, we failed to adequately study the social aspects of play, which may have been significant factors in sustained PA. We did not measure exergame intensity at baseline but did capture the intensity of the exergame at the final measurement event at the school. Perhaps the reason that one school accumulated more minutes per child of exergaming was due to a "champion" who was an engaged math teacher, who encouraged students to take more motor breaks, but we did not adequately measure this adult factor in this pilot. Our pilot was only 20 weeks in duration, and if we had continued another semester, participation could drop off as the "new toy" effect wore off. On the other hand, we predicted that youth would tire of this game after about 6 weeks, but students spent even more time during exergame engagement over the second half of the semester.

Despite these limitations, our findings provide initial evidence that using exergames can boost PA in middle schools. Exergames have become attractive as a potential strategy for health improvement, but more research is needed about best practices and their uses—notably in social contexts. Additionally, questions concerning dose, duration, and frequency remain. Future studies may benefit from showcasing novel exergames in more prominent school locations or by incorporating contests and incentives to increase engagement. It remains to be seen if this can be implemented on a larger scale and not detract from other important school educational aims, but there is reason for optimism that youth will continue to be attracted to high-tech gaming approaches to boost their activity.

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Author Disclosure Statement

No competing financial interests exist.

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