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Instructor-led versus Video-led Exercise: A Comparison of Intensity in Obese Youth

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ABSTRACT

Background: Exercise is a key component in treating childhood obesity. Group exercise sessions with a trained instructor are ideal, but most treatment programs cannot offer these often enough to meet physical activity guidelines. At-home options that provide a similar-intensity workout are needed. **Objective:** To determine if exercise videos are a feasible at-home option for obese youth to meet recommended physical activity guidelines for moderate-to-vigorous exercise. **Methods:** Obese youth attended a summer camp focused on weight management. Subjects wore accelerometers to assess physical activity levels at camp. During camp, all subjects completed four exercise activities: three separate exercise sessions led by exercise physiologists (EP), as well as an exercise video (EV). Each exercise session utilized a different format: high intensity interval training (HIIT), group games (GG) and yoga. The EV, created by the same EP, included aerobic exercise and yoga. Data was analyzed to determine intensity associated with each exercise session. **Results:** Data was obtained from 16 (50%) accelerometers (9 girls, 7 boys). There was no difference in sedentary (SED) minutes per hour between activities. HIIT and GG had more moderate-vigorous physical activity (MVPA) than yoga ($p<0.0001$ and $p=0.01$) and EV ($p<0.0001$ and $p=0.01$). There was no difference in MVPA between HIIT and GG. **Conclusions:** Obese children exercised at higher intensities during instructor-led HIIT and GG exercise sessions than yoga or EV sessions.

Key words: Obesity, Pediatric Obesity, Overweight, Exercise, Instructional Films and Videos

INTRODUCTION

Over the past thirty years, prevalence of pediatric obesity has increased, placing it among the most important health care issues facing youth (Ogden et al., 2016). Though some studies suggest that pediatric obesity rates may be plateauing, a more in-depth look reveals that rates of severe obesity have increased (Ogden et al., 2016; Skinner, Perrin, & Skelton, 2016). In children and adolescents, obesity is defined as a body mass index (BMI) at the 95th percentile or above for age and gender. "Severe obesity" is classified as ≥120% of the 95th percentile for BMI (Daniels & Kelly, 2014). It is now estimated that 31.8% of youth, ages 2-19, are overweight or obese. Of those, 17% are obese, of which 5.8% can be classified as severely obese (Ogden et al, 2016; Skinner et al., 2016; Ogden, Carroll, Kit, & Flegal, 2014). Youth with overweight and obesity can develop co-morbidities such as hypertension, hyperlipidemia, fatty liver disease, Type 2 diabetes, polycystic ovarian syndrome, orthopedic concerns and obstructive sleep apnea (Kelly et al., 2013; Dietz, 1998; Maggio et al., 2014). Research by the World Obesity Federation has estimated that by 2025, if no effective treatment interventions are identified, 268 million children worldwide, ages 5-17, will be overweight or obese. Of these, an estimated 12.7 million will have impaired glucose tolerance, 4 million will have from type 2 diabetes, 27 million will have hypertension and 38 million will have hepatic steatosis (Lobstein & Jackson Leach, 2016). Pediatric obesity also often leads to adult obesity, co-morbidities and shortened lifespan (Reilly & Kelly, 2011).

Many comprehensive weight management programs for children have been established to address these issues. Physical activity and exercise are important components of these programs. Many programs offer group exercise sessions to their patients. Of 23 pediatric weight management programs surveyed, 74% offered patients the opportunity to participate in group exercise classes (Kist et al., 2016). However, these exercise classes are not always offered daily, and some patients may not be able to attend group sessions due to distance, lack of transportation or scheduling conflicts. Because of this, weight management programs also provide prescriptions for at-home exercise, often consisting of age-appropriate exercise like active play. However, children often face

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barriers to exercise at home. Many children don't know what type of exercise they can do indoors, especially within the confines of small space or no equipment. Lack of safe outdoor environments and equipment (Kottyan, Kottyan, Edwards, & Unaka, 2014; Lee et al., 2015) as well as extreme weather conditions (Edwards et al., 2015) can limit free play. In addition, independent free play outdoors may not be of sufficient intensity to meet activity guidelines. Previous research done by this group found that in obese youth who attended a week-long summer camp, group exercise led by an exercise physiologist was superior to self-paced exercise in achieving higher levels of moderate-to-vigorous physical activity (MVPA)(Gier et al., 2014). Ideally, exercise done by patients at home will be of sufficient intensity to meet the current guidelines set for children. Current recommendations state that children should accumulate at least 60 minutes of daily activity. Additionally, most of the 60 minutes should be aerobic in nature and of moderate or vigorous intensity. Vigorous intensity exercise should be included at least three days each week (US Department of Health and Human Services, 2008). According to the 2016 United States Report Card on Physical Activity for Children and Youth, only 22% of US children and adolescents, ages 6-19, meet the current recommendations of 60 minutes of MVPA at least 5 days per week (National Physical Activity Plan Alliance).

Exercise videos may help remove some of these barriers to achieving the recommended amount and intensity of exercise. They can be done in the safety of a patient's home with little-to-no costly equipment and overcome the barriers of distance, schedules and transportation (Killen, Barry, Cooper, & Coons, 2014). In addition, they can serve to provide patients with age-appropriate exercises of adequate intensity, recommended and demonstrated by exercise professionals (Gothe et al., 2015). Some research has been conducted using exercise videos for home workouts in various age groups and health conditions. At the conclusion of a 6-month study with older adults, those participating in a home exercise program via DVD accumulated more time in MVPA than those in the control group, when measured via accelerometers and self-report (Gothe et al., 2015). Conversely, a study of college-aged females found that subjects completed identical workouts at a higher intensity with a live personal trainer versus a pre-recorded video session (Killen et al., 2014). Regarding the use of exercise videos in children, a 2002 pilot study in a school setting found that over half of the participating first and second grade students were excited about actively following along with a 15-minute interactive video about health (Levin, Martin, McKenzie, & DeLouise). Another school-based study found that during an indoor recess, children following along to a dance video were physically active for 68% of the recess period (Erwin, Koufoudakis, & Beighle, 2013). A more recent pilot study found that pre-school children engaging in a "movement-to-music" exercise video with their mothers at home accumulated more light and MVPA than children who did not use the video (Tuominen, Husu, Raitanen, & Luoto, 2016). However, a follow-up randomized controlled trial found no significant differences in light activity, MVPA or sedentary time between children using the video and the control group (Tuominen, Husu, Raitanen, Kujala, & Luoto, 2017).

Other technology-driven interventions, such as internet-based activity or active videos games, have also been researched. A review of literature examining the use of technology in adolescent obesity interventions found that, out of eleven studies, six saw improvements in physical activity measures (Chen & Wilkosz, 2014). A review of studies looking at active video games found that they produced similar intensity levels to traditional, moderately active free play and sports (Peng, Lin, & Crouse, 2011). In addition to removing physical barriers to exercise, utilizing technology in pediatric obesity interventions may help increase motivation. Screens and technology continue to become more ever-present in the daily lives of children and adolescents. In children under the age of 8 years old, 98% have access to both televisions and mobile devices in their homes; 95% have at least one smart phone in the home, and 78% have access to tablets. In this age group, 42% have their own "personal" tablet (Common Sense, 2017). In households of "tweens," defined as children ages 8-12 years old, 94% have televisions, 79% have smart phones and 80% have tablets. In households with teenagers, ages 13-18 years old, 95% have televisions, 84% have smart phones and 73% have tablets. 24% of tweens and 67% of teens have their own smart phones, while 53% of tweens and 37% of teens have their own tablets (Common Sense, 2015).

These statistics suggest that screens are a very familiar medium for youth today. Quelly, Norris and DiPietro (2015) refer to young people as "digital natives accustomed to interacting with computers and cell phones for most of their lives." Because children have grown up with technology and seem drawn to it, it seems plausible that incorporating this technology into exercise prescriptions may serve as a way to increase motivation. A systematic review of the use of mobile apps in pediatric obesity interventions found that one study improved "positive attitudes" toward specific exercises, while three other studies demonstrated increased motivation through the use of apps (Quelly et al., 2015). A review of exergaming studies conducted in "field-based settings, such as schools, communities and homes," found three interventions demonstrating a positive outcome with regards to enjoyment and motivation to exercise through the use of active video games (Gao & Chen, 2014). For pediatric weight management programs that are unable to offer group exercise classes, or for their patients who have barriers to attending classes, it is necessary to offer motivating options for at-home exercise to help children meet guidelines for frequency, duration and intensity of daily exercise. The findings above suggest that it may be feasible to use exercise videos or other technology with obese children to increase higher intensity exercise at home. This clinical pediatric weight management program filmed its own exercise video, specifically for youth, with a goal of providing patients with a more structured, higher-intensity option for at-home exercise. The purpose of this study is to analyze the effectiveness and intensity of an exercise video when compared to similar workouts led in-person by an exercise physiologist.

METHODS

Design of Study and Participants

The Institutional Review Board at Cincinnati Children's Hospital Medical Center approved the study protocol. This is a quantitative quasi-experimental, within-subjects study of exercise intensity in overweight and obese children. Current patients of a clinical weight management program were invited to attend a 6-day summer camp. Camp consisted of a variety of daily activities of various intensity, as well as healthy meals and snacks. Participation in camp was limited to patients ages 9-13 years old. Non-English speaking patients were excluded from the study. All campers and their legal guardians were approached and offered the opportunity to participate in the study. Informed consent and assent (ages 11-13) was obtained. Thirty-two campers enrolled in the study. All subjects were assigned to the physical activity intervention. Each subject completed each of four exercise activities.

Study procedures

Accelerometers were individually programmed with gender, date of birth, height and weight of each subject. Accelerometers were labeled with each subject's study ID number. Camp counselors were provided with each subject's study ID to ensure the same accelerometer was used by each subject throughout the week. Subjects wore their accelerometers at the waist on their non-dominant side. Accelerometers were worn at all times during camp except when swimming, bathing and sleeping. Accelerometers were collected from subjects at the conclusion of camp. During the week of camp, all subjects completed four exercise activities. Three activities were led by an exercise physiologist (EP), and one activity was conducted via exercise video (EV). An EP led all subjects through exercise sessions on three separate mornings. The duration of each EP-led activity was approximately 20-30 minutes. Each EP-led exercise session utilized a different format: high intensity interval training (HIIT), yoga and active group games (GG). All EP-led sessions included a brief warm-up and cool-down. The EV activity included aerobic exercise, yoga, a warm-up and cool-down. Subjects followed along with the on-screen exercises for approximately 52 minutes. The EV was created for obese youth by the same EP guiding the instructor-led exercise activities.

Outcome Measures

The primary outcome measures of this study were sedentary minutes and moderate-to-vigorous minutes per exercise activity, objectively assessed through the use of triaxial accelerometers (RT3, Stayhealthy Research®). Activity counts per hour were assessed as a secondary outcome measure. Accelerometers were placed on subjects during their first morning at camp and continuously recorded activity throughout the week. The camp schedule of daily activities was used to establish timeframes of measurement to isolate only the EP-led and video-led exercise sessions for data analysis.

Analysis

Statistical Analysis Software (SAS®) was used to clean and process data. Mixed models repeated measures analyses were performed to account for multiple observations per subject. The covariance structure used in these analyses was compound symmetry. Exercise session and subject id were fixed effects, with id being repeated. The estimation method was restricted maximum likelihood (REML). Differences in mean levels of moderate-to-vigorous minutes, sedentary minutes and activity counts per hour between exercise activities were compared using LSMEANS. Results were considered significant at a value of $p \leq 0.05$.

RESULTS

Usable data were obtained from 16 accelerometers (50%). Data were obtained from 9 girls and 7 boys. Mean age of subjects was 11.3 ± 1.2 years. Mean BMI was 31.5 ± 5.3 kg/m^2 with a BMI z-score of 2.32 (Table 1). In a mixed models analysis, exercise activity had a significant effect on sedentary minutes ($F(4,43)=128$, $p<0.0001$), MVPA ($F(4,43)=19$, $p<0.0001$) and activity counts per hour ($F(4,43)=34$, $p<0.0001$). There was no significant difference in sedentary (SED) minutes per hour between any of the activities (all $p \geq 0.19$) (Table 2). HIIT and GG produced more MVPA than yoga ($p<0.0001$ and $p=0.01$) and EV ($p<0.0001$ and $p=0.01$) (Table 3) (Figure 1). There was no significant difference in MVPA between HIIT and GG ($p=0.12$), though HIIT elicited significantly higher activity counts per hour (mean value=1002) than GG (mean value=854) ($p=0.02$) (Table 4).

DISCUSSION

While the exercise video used in this study effectively reduced sedentary time, obese children did not attain as much

Table 1. Characteristics of participants

Variables	Group (n=16)	Males (n=7)	Females (n=9)
Age (year)	11.3±1.2	11.3±1.0	11.2±1.5
Height (cm)	156.2±10.5	153.8±10.6	158.1±10.7
Weight (kg)	78.0±20.8	70.3±15.0	84.0±23.5
BMI (kg/m^2)	31.5±5.3	29.5±4.0	33.1±5.9

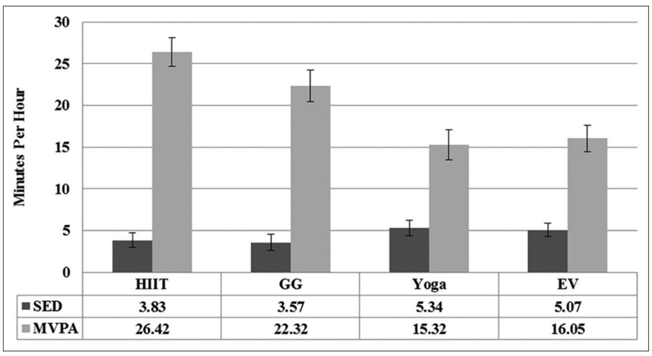

Figure 1. Differences in sedentary and moderate-to-vigorous minutes per hour between high-intensity interval training

Table 2. Difference in sedentary minutes between per hour between exercise activities

Activity	Activity	Difference(minutes)	Standard Error	DF	t-value	p-value
GG	Yoga	–1.7692	1.3308	43	–1.33	0.1907
GG	EV	–1.5064	1.2328	43	–1.22	0.2284
GG	HIIT	–0.2592	1.3219	43	–0.20	0.8454
Yoga	EV	0.2628	1.1912	43	0.22	0.8264
Yoga	HIIT	1.5099	1.2975	43	1.16	0.2509
EV	HIIT	1.2471	1.1983	43	1.04	0.3038

High-intensity interval training (HIIT), group games (GG) and exercise video (EV)

Table 3. Difference in moderate-to-vigorous minutes per hour between exercise activities

Activity	Activity	Difference(minutes)	StandardError	DF	t-value	p-value
GG	Yoga	6.9947	2.6082	43	2.68	0.0103
GG	EV	6.2639	2.4161	43	2.59	0.0130
GG	HIIT	–4.1006	2.5907	43	–1.58	0.1208
Yoga	EV	–0.7308	2.3346	43	–0.31	0.7558
Yoga	HIIT	–11.0953	2.5428	43	–4.36	<0.0001
EV	HIIT	–10.3645	2.3486	43	–4.41	<0.0001

High-intensity interval training (HIIT), group games (GG) and exercise video (EV)

Table 4. Difference in activity counts per hour between exercise activities

Activity	Activity	Difference(counts)	Standard Error	DF	t-value	p-value
GG	Yoga	214.32	61.6352	43	3.48	0.0012
GG	EV	143.80	57.0966	43	2.52	0.0156
GG	HIIT	–147.89	61.2215	43	–2.42	0.0200
Yoga	EV	–70.52	55.1707	43	–1.28	0.2080
Yoga	HIIT	–362.21	60.0907	43	–6.03	<0.0001
EV	HIIT	–291.69	55.5005	43	–5.26	<0.0001

High-intensity interval training (HIIT), group games (GG) and exercise video (EV)

MVPA during the video as they did during EP-led group exercise, such as active games and HIIT. Children were engaged in MVPA 44% of the time spent participating in HIIT and 37% of time spent participating in GG. The difference between HIIT and GG was not significant. However, time spent in MVPA during the exercise video (27%) was significantly lower. MVPA during instructor-led yoga (25%) was comparable to the EV and lower than HIIT and GG. This suggests that obese children are more likely to meet recommendations for MVPA when completing workouts in person instead of via an exercise video. Screens and technology now occupy a large part of the everyday life of children. Common Sense Media found that children between the ages of 8 and 12 years old engage in "entertainment media" almost 6 hours per day, and teenagers average close to 9 hours daily (2015). Health interventions are increasingly capitalizing on this widespread use of technology as a new way to deliver programming. Exercise videos, in particular, are one method. The purpose of this study was to determine if the use of an EV by obese youth resulted in a similar intensity workout to a session being delivered in-person by an exercise physiologist. The results demonstrated the EV is less effective.

Children may be more willing to push themselves to work at a higher intensity with an exercise physiologist present. In the study of college-aged women completing an identical workout with a trainer and then via an exercise DVD, it was suggested that an in-person trainer provides greater levels of encouragement, leading to increased effort. The researchers arrived at this conclusion in part because the women reported no significant differences in enjoyment, comfort or confidence between the sessions (Killen et al., 2014). A study examining physical activity during indoor recess in a sample of 8- to 12-year-old students utilized custom dance videos. The students did these with no instruction or encouragement from an in-person adult. Results showed children spent approximately 22% of the indoor recess engaged in MVPA (Erwin et al., 2013), similar to the results of 27% with the exercise video in this current study. While the video was not as effective as in-person exercise sessions with an exercise physiologist, it may still yield higher exercise intensities than self-paced workouts at home. Though intended for home use, the exercise video was examined in a group summer camp setting for ease of assessment. Future research may determine if obese youth using the exercise video at home work at higher intensities than during self-chosen physical activity such as walking, biking or sports with friends in a home or community environment. Further studies could also look at effectiveness of the exercise video when obese youth do not have the option of outdoor play or exercise, due to weather or safety. Obese youth given access to an exercise video may accumulate more intense activity and less sedentary time inside versus children without a video. With this, it would be beneficial to examine delivery method of home workouts, as well. With rapidly changing technology, children may be more apt to perform exercise when they can access it through an app or streaming device versus the more outdated DVD.

One limitation of the study is that the video included both yoga and aerobic exercise, while yoga was evaluated independently when analyzing EP-led group exercise. Future research could examine only the aerobic portions of the EV to better compare intensities between EP-led and video-led exercise in obese youth, which may lead to higher percentages of time being spent in MVPA during an EV (Gier et al., 2015). This study had other limitations. Sample size was small, limited by total number of accelerometers available and reliability of devices – only 16 accelerometers (50%) had usable data. This study does not examine long-term adherence to exercise videos in a pediatric population. Future research could examine this, as well as age or gender differences associated with enjoyment, effort and intensity levels when using exercise videos for home workouts.

CONCLUSION

A variety of exercise formats can be used in exercise prescriptions to improve health and BMI in obese youth by reducing sedentary time and meeting the guidelines of 60 minutes of daily MVPA. Thus, while exercise videos were not as effective as instructor-led workouts to elicit MVPA, they can be offered to obese youth as a safe, low-cost, potentially motivating option for at-home exercise.

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