Prevalence and Correlates of Exergaming in Youth

AUTHORS: Erin K. O'Loughlin, MA,[a] Erika N. Dugas, MSc,[a] Catherine M. Sabiston, PhD,[b] and Jennifer L. O'Loughlin, PhD[a,c,d]

[a]*Centre de Recherche du Centre Hospitalier de l'Université de Montréal, Montreal, Quebec, Canada;* [b]*Faculty of Kinesiology and Physical Education, University of Toronto, Toronto, Ontario, Canada;* [c]*Department of Social and Preventive Medicine, University of Montréal, Montreal, Quebec, Canada; and* [d]*Institut National de Santé Publique du Québec, Montreal, Quebec, Canada*

KEY WORDS

exergaming, youth, correlates, guidelines, physical activity, active video games, adolescents

ABBREVIATIONS

MVPA—moderate-to-vigorous physical activity
PA—physical activity
SES—socioeconomic status

Ms E. O'Loughlin reviewed the literature, contributed to the design of the analysis and interpretation of the data, and wrote sections of the article; Dr Sabiston, Ms E. Dugas, and Dr J. O'Loughlin contributed to the design and interpretation of the analysis and wrote sections of the manuscript; and Dr J. O'Loughlin designed the study, obtained the funding, developed the survey instruments and supervised data collection. All authors reviewed the article critically and approved the final version.

www.pediatrics.org/cgi/doi/10.1542/peds.2012-0391

doi:10.1542/peds.2012-0391

Accepted for publication Jun 27, 2012

Address correspondence to Jennifer L. O'Loughlin, PhD, Department of Social and Preventive Medicine, University of Montreal, 3875 St Urbain (1st Floor), Montreal, Quebec H2W 1V1. E-mail: jennifer.oloughlin@umontreal.ca

PEDIATRICS (ISSN Numbers: Print, 0031-4005; Online, 1098-4275).

Copyright © 2012 by the American Academy of Pediatrics

FINANCIAL DISCLOSURE: *The authors have indicated they have no financial relationships relevant to this article to disclose.*

FUNDING: Supported by the Canadian Cancer Society (grant 15689) and the Institut national de santé publique du Québec. Dr J. O'Loughlin holds a Canada Research Chair in the Early Determinants of Adult Chronic Disease.

WHAT'S KNOWN ON THIS SUBJECT: Exergaming offers a physical activity (PA) alternative for youth that may be attractive in our increasingly technophilic society. Exergaming increases PA and decreases sedentary time, but most exergame studies are clinically based and focus on measuring energy expenditure during exergaming.

WHAT THIS STUDY ADDS: One-quarter of adolescents exergamed at intensity levels that could help them achieve PA recommendations. Exergamers were more likely to be female, play nonactive video games, watch ≥2 hours of television per day, be stressed about weight, and be nonsmokers.

abstract

FREE

OBJECTIVES: Less than 15% of children and adolescents participate regularly in physical activity (PA) and, with ever-increasing obesity, strategies to improve PA levels in youth are urgently needed. Exergaming offers a PA alternative that may be especially attractive in our increasingly technophilic society. However, there are no observational studies of exergaming in population-based samples of adolescents. The purpose of this study was to investigate potential sociodemographic, lifestyle, psychosocial, weight-related, and mental health correlates of exergaming as well as describe the type, timing, and intensity of exergaming in a population-based sample of adolescents.

METHODS: Data on exergame use and potential sociodemographic, lifestyle, psychosocial, weight-related, and mental health correlates of exergaming were collected in mailed self-report questionnaires completed by 1241 grade 10 and 11 students from the Montreal area with a mean age of 16.8 years (SD = 0.05 years; 43% male) participating in the AdoQuest study. The independent correlates of exergaming were identified in multivariable logistic regression models.

RESULTS: Nearly one-quarter (24%) of participants reported exergaming. Exergamers played 2 days per week on average, for ~50 minutes each bout; 73% of exergamers played at a moderate or vigorous intensity. Exergamers were more likely than nonexergamers to be girls, to play nonactive video games, to watch ≥2 hours of television per day, to be stressed about weight, and to be nonsmokers.

CONCLUSIONS: Many adolescents exergame at intensity levels that could help them achieve current moderate-to-vigorous PA recommendations. Interventions that encourage exergaming may increase PA and decrease sedentary behavior in select youth subgroups, notably in girls. *Pediatrics* 2012;130:1–9

Downloaded from http://pediatrics.aappublications.org/ by guest on December 12, 2017

Physical activity (PA) may be key to preventing, controlling, and reducing obesity,[1] yet PA levels in children and adolescents have declined markedly in the past 2 decades[2,3] and few youth meet current PA guidelines.[4,5] Many PA interventions for youth do not have short- or long-term impact,[6] and it is becoming critical to identify effective and sustainable strategies to increase PA in youth. Active video games offer a PA alternative that may be both popular and effective in our increasingly technophilic society.[7]

Active video games are games in which individuals or groups of individuals interact in a physically active manner by using technology.[8] There are 3 types of active video gaming: exergames, interactive fitness activities, and active learning games.[9] Exergames include rhythmic dancing games, virtual bicycles, balance board simulators, and virtual sports simulators, all of which require a screen and console such as the Wii. Interactive fitness activities such as HOPSports1 are non-screen-based games but require technology, and players must be physically active to play the game. Finally, active learning games such as Footgaming are screen-based games with an academic focus that require PA.[9] The current study focuses on exergames.

Exergaming capitalizes on the popularity of traditional video games, which are used by 83% of American youth.[10] When exergaming, participants assume character roles, and their movements are tracked on-screen as they attempt to attain an objective.[8,11,12] No specific skills or fitness levels are required to begin playing.[13] Exergaming increase PA in general,[14] as well as in specific populations such as visually impaired children.[15] They are generally played at home but are also used in schools and community centers.[16,17] Because exergames can be played in a variety of settings including unsafe neighborhoods,[18] they can increase opportunities for youth to engage in PA[11,12,16,19,20] and decrease sedentary behavior.[18,19,21–25]

Exergaming may have added value in youth compared with adults because young people are generally more physically active (ie, move more) while exergaming,[26] and game exertion (effort) is not a deterrent to exergaming.[27] Exergaming may be more enjoyable than sedentary video games and treadmill workouts,[28] and they provide youth with opportunities to try a range of sports (eg, boxing, kung fu), which may in turn increase motivation to become involved in these activities at school or local sports centers.[29]

The primary purpose of extant exergaming studies has been to describe energy expended during exergaming.[12,16,17,23,24,26,30–37] Several studies also examine maintenance of exergaming over time,[38–42] and at least 3 small[43] and 1 large trial[44] evaluate exergaming as a method to increase PA in youth. Two of the 3 small trials indicated modest improvements in PA, and the large longer trial suggested that exergaming leads to small but statistically significant decreases in BMI as well as improvements in body composition in overweight children.[44] Finally, the effect of exergaming on rehabilitation has been investigated in several studies.[45–48]

Most research on exergaming to date has been conducted in clinical settings so that little is known about the type, duration, or intensity of exergaming in population-based samples of adolescents. In addition, it is not known if the sociodemographic, lifestyle, psychosocial, health, or weight-related characteristics of youth who exergame differ from those who do not.[18] In this study, we describe exergame use in a large population-based sample of adolescents and identify the independent correlates of exergaming. Increased understanding of the characteristics of exergamers, as well as where exergames are played and which ones are most popular, may inform the development of interventions that improve PA participation in youth.[18]

METHODS

Data were drawn from the AdoQuest study, a prospective cohort investigation of 1843 students aged 10 to 12 years at cohort inception, which was designed to investigate the natural course of the co-occurrence of health-compromising behaviors in children.[49] The sample was drawn from a stratified random sample of schools selected from among all French-language schools with >90 grade 5 students in the greater Montreal area (Quebec, Canada). To ensure equal representation of participants within different socioeconomic status (SES) strata, all schools located in the target territory were stratified based on a continuous SES indicator,[50] and 9 or 10 schools were randomly selected from within each of the upper, middle, and lower school SES tertile groupings. Study participants were recruited from all grade 5 classes in each of the 29 participating schools. All participants provided written assent, and their parents/guardians provided written informed consent. In addition, parents completed mailed self-report questionnaires in 2006–2007 and again in 2008–2009. The study received ethics approval from the Research Ethics Boards of the Faculty of Medicine of McGill University, the Conseil sur l'Éthique et la Recherche, Concordia University, and the Centre de Recherche du Centre Hospitalier de l'Université de Montréal.

This current cross-sectional analysis uses data collected in 2010–2011 when participants were aged 14 to 19 years and in grades 10 or 11. Data on sociodemographic characteristics, cigarette smoking, exergame use, PA,

Downloaded from http://pediatrics.aappublications.org/ by guest on December 12, 2017

depression, anxiety, stress, and substance use were collected in mailed self-report questionnaires completed by 1241 of the original 1843 participants (67%). In general, the questions used in the AdoQuest questionnaire were drawn from ongoing surveys and studies of youth including the Canadian Youth Smoking Survey[51] and the Nicotine Dependence in Teens Study.[52] The AdoQuest questionnaire was pretested for readability and comprehension by 15 persons including students in the same age range as AdoQuest participants and the AdoQuest investigators (which include a public health physician, PA experts, and a psychiatrist who works with youth).

Study Variables

We modeled the questions on exergaming type and perception of intensity and timing on the short self-administered usual week International Physical Activity Questionnaire, which is used in cross-national monitoring of PA in youth and adults. The questionnaire demonstrates reliability as well as validity against accelerometer data.[53] Specifically, exergaming was measured by asking participants: "Do you play active video games (ex: Wii Fit, Dance Dance Revolution)?" (yes/no). Those who responded "yes" were asked (1) how many days a week they played active video games (participants responded 1–7 days); (2) how many minutes (on average) they played each time (open-ended); (3) the effort of play (light, moderate, vigorous as perceived by the participant); (4) location of play: "Do you play the following games at your house, your friend's house, or at school? (Please check all that apply)"; and (5) which specific exergames they played.

Potential correlates of exergaming were selected based on known PA correlates in adolescence,[54] as well as on the availability of data in AdoQuest. Sociodemographic variables investigated included age, gender, currently employed (yes/no), and Caucasian (yes/no). In addition, data on mother university-educated (yes/no) and annual household income (<30 000, 30 000–99 999, >100 000$ CAN) were drawn from the parent questionnaire.

Data on substance use included current cigarette smoking status and past 12-month binge drinking (at least 5 drinks on 1 occasion), marijuana use, and use of other illicit drugs (heroin, ecstasy, hallucinogens).[55] Participants were coded yes or no for each substance if there was indication of any use in the past 12 months.

PA was measured in 4 indicators from the International Physical Activity Questionnaire, which demonstrates reliability and validity against accelerometer data.[53] Vigorous PA was measured in 2 items: "During the last 7 days, on how many days did you do vigorous physical activities (heavy lifting, digging, aerobics, fast bicycling) for at least 10 minutes at a time?" and "On the days that you did vigorous physical activities, how many minutes did you usually do per day?" Moderate PA was measured by asking, "In the last 7 days, on how many days did you do moderate physical activities (carrying light loads, bicycling at a regular pace, doubles tennis) for at least 10 minutes? " and "On the days that you did moderate physical activities, how many minutes did you usually do per day?" Minutes of moderate and vigorous PA were totaled to create a moderate-to-vigorous physical activity (MVPA) score. Participants were categorized as meeting MPVA guidelines (ie, adolescents should engage in MVPA for 420 minutes/week) if they reported at least 60 minutes of moderate or vigorous PA most days.[56]

Participants provided data on sedentary screen-time behavior including use of nonactive video games, watching television, and spending time on a computer. Each was coded as <2 or ≥2 hours per day based on recently established screen time guidelines.[57]

Data were collected on 3 weight-related indicators including BMI (computed by using self-reported height and weight). Participants were classified by using Centers for Disease Control and Prevention reference standards, which are gender- and age-specific,[58] as normal weight (<85th percentile), overweight (≥85 to <95th percentile), or obese (≥95th percentile). Self-perceived weight status was categorized as either normal or overweight (if participants self-reported that they were "a bit heavy" or "much too heavy"). Finally, participants were categorized as trying to lose weight (yes/no).

Data on stress or worry about common problems in adolescence (yes/no) were collected with the question, "Did you ever in your life experience: (1) changes in your weight or your physical appearance that you did not like; (2) being cut from a sports team, club, or other organization; (3) suffer from a health problem (asthma, acne); and (4) problems being accepted by your peers?"

Depression symptoms were measured in the validated 6-item Kandel Depressive Scale,[59,60] which assessed how often (never, rarely, sometimes, often, always) in the past 7 days participants (1) felt too tired to do things; (2) had trouble going to sleep or staying asleep; (3) felt unhappy, sad, or depressed; (4) felt hopeless about the future; (5) felt nervous or tense; and (6) worried too much about things. Responses were summed and then divided by the number of items responded to, to create a depression symptom score that ranged from 1 to 5 (mean [SD] = 2.22 [0.8]) with higher values indicating more frequent depression symptoms. If participants did

Downloaded from http://pediatrics.aappublications.org/ by guest on December 12, 2017

not answer ≥50% of the items, the code was set to missing.

Participants provided data on whether they had ever been diagnosed (yes/no) by a health professional with an anxiety disorder (phobia, obsessive-compulsive disorder, panic attacks, generalized anxiety disorder), eating disorder (anorexia, bulimia), or attention-deficit/hyperactivity disorder.

Data Analysis

The association between each potential correlate and exergaming (yes/no) was investigated in univariate logistic regression modeling. Variables associated with exergaming at $P < .25$ were included in a multivariable logistic regression model.[61] All analyses were conducted by using SPSS software, version 16.0 (SPSS Inc, Chicago, IL).

RESULTS

Thirty-two of the 1241 participants who completed questionnaires in 2010–2011 were excluded due to missing data on exergaming, so that the final analytic sample was $n = 1209$. Compared with participants not retained for analysis ($n = 634$), significantly higher proportions of those retained ($n = 1209$) were female, had a university-educated mother, and had an annual household income >100 000$ (CAN) (Table 1). In addition they were younger on average.

The mean (SD) age of participants was 16.8 (0.5) years, 43% were boys, 92% were Caucasian, 76% were in grade 11, 47% were employed, and 27% had university-educated mothers. The mean (SD) BMI was 22.8 (3.9) in males, and 21.5 (3.5) in females. Fifty percent of participants' parents reported an annual household income that ranged from $30 000 to 99 999, 7% reported an annual income of <$30 000, 24% reported an annual income of >$100 000 (Canadian dollars), and data were missing for 19% of participants.

TABLE 1 Comparison of Selected Sociodemographic Characteristics of Participants Retained and Not Retained for Analysis (AdoQuest 2005, 2010–2011)

	Retained ($n = 1209$)	Not Retained[a] ($n = 634$)	*P* Value for Difference
Boys, %	45.1	55.2	.003
Age at baseline, mean (SD)	10.7 (0.5)	10.8 (0.6)	<.000
Mother university-educated, %[b]	32.1	24.6	.010
Annual household income ($ CAN), %[c]			.002
<30 000	8.6	13.8	
30 000–99 999	61.9	65.2	
≥100 000	29.5	21.0	

[a] Includes 602 participants who did not complete a questionnaire in cycle 6, and 32 participants who completed survey cycle 6 but were missing data on exergaming.
[b] Excludes 452 participants missing data on mother's education.
[c] Excludes 588 participants missing data on annual household income.

Two hundred eighty-four participants (24% of 1209) reported exergaming. Exergamers played a mean (SD) of 2.0 (1.4) days per week, for a mean (SD) of 50.5 (36.4) minutes per bout. Twenty-seven percent reported that they exergamed at light intensity, 57% exergamed at moderate intensity, and 16% exergamed at vigorous intensity. Twenty-three exergamers (8%) did not respond to this item.

Wii Sports (68% of exergamers), Dance Dance Revolution (40%), Wii Fit Yoga (34%), and Boxing (Punchout; 15%) were the most popular exergames played at home. Wii Sports (26%) and Dance Dance Revolution (29%) were played most frequently at friends' homes. Less than 1% of exergamers reported exergaming at school (Table 2).

In multivariable analysis, exergamers were significantly ($P < .05$) more likely than nonexergamers to be female, to play nonactive video games, to be stressed about their weight, and to watch ≥2 hours of television per day. Exergamers were significantly less likely to smoke cigarettes (Table 3).

DISCUSSION

Almost one-quarter of participants in this population-based sample of adolescents exergamed. On average, they played 2 days per week for an average of 50 minutes per bout, and 73% played at moderate or vigorous intensity. Current PA guidelines for youth recommend 60 minutes of MVPA most days per week[56,62] so 73% of exergamers were close to meeting MVPA guidelines at least 2 days per week. In contrast, Colley et al (2011) reported that 80% of boys and 67% of girls in this age group met MVPA guidelines only 1 day per week.[4] In our

TABLE 2 Exergames Played by Grade 10 and 11 Students in Montreal, Canada, According to Location Where Game Was Played (AdoQuest 2010–2011)

	At Home, %	At Friend's Home, %	At School, %
Wii Sports	68	26	<1
Dance Dance Revolution	40	29	1
Wii Fit: Yoga	34	12	0
Boxing (Punchout)	15	6	1
Just Dance	6	3	<1
Kinect (console)	6	1	0
EA Active	6	3	<1
Eye Toy (Groove, Hero, Kinetic Combat, Play Sports)	4	4	<1
Yourself Fitness!	4	3	<1
Pump It Up	3	4	0
Jenny McCarthy (In Shape)	<1	2	<1
Powergrid Fitness Kilowatt	1	2	<1
Cyclescore	<1	3	<1
Other	6	2	0

Downloaded from http://pediatrics.aappublications.org/ by guest on December 12, 2017

TABLE 3 Crude and Adjusted ORs for Potential Correlates of Exergaming Among Grade 10 and 11 Students in Montreal, Canada (AdoQuest 2010–2011)

	n[a]	Exergame, %	OR_{crude} (95% CI)	*P* Value	OR_{adj}[b] (95% CI)	*P* Value
Sociodemographic characteristics						
Age, y				.015		.315
14–15	64	48.8	0.7 (0.6–0.9)[c]		0.9 (0.6–1.2)	
16–17	1119	23.0				
18–20	16	25.0				
Gender				<.000		<.000
Female	685	29.1	Ref		Ref	
Male	524	16.2	0.5 (0.4–0.6)		0.3 (0.2–0.4)	
Caucasian				.792	—	—
No	86	24.4	Ref			
Yes	1109	23.2	0.9 (0.6–1.6)			
Mother university-educated					—	—
No	646	24.1	Ref	.749		
Yes	232	23.2	1.1 (0.7–1.7)	.520		
Missing	240	22.1	0.9 (0.1–1.1)			
Employed				.252		.745
No	641	24.8	Ref		Ref	
Yes	568	22.0	0.9 (0.7–1.1)		1.0 (0.7–1.3)	
Annual household income, $CAN					—	—
<30 000	82	29.3	Ref	.265		
30 000–99 000	597	23.6	0.8 (0.5–1.2)	.354		
≥100 000	285	24.2	0.8 (0.5–1.3)	.099		
Missing	245	20.4	0.6 (0.4–1.1)			
Lifestyle habits						
Current smoker				.030		.008
No	1069	24.4	Ref		Ref	
Yes	136	16.2	0.6 (0.4–1.0)		0.5 (0.3–0.8)	
Binge drinking				.734	—	—
No	554	22.9	Ref			
Yes	644	23.8	1.1 (0.8–1.4)			
Marijuana use				.879	—	—
No	894	23.4				
Yes	305	23.0	1.0 (0.8–1.4)			
Used other illicit drugs				.760	—	—
No	1099	23.7	0.9 (0.6–1.5)			
Yes	103	22.3				
Nonactive videogames, h/d						
None	727	18.8	Ref		Ref	
<2	369	31.7	2.0 (1.5–2.7)	<.000	4.0 (2.7–6.0)	<.000
≥2	105	25.7	1.5 (0.9–2.1)	.100	4.0 (2.2–7.3)	<.000
Television, h/d						
None	54	11.1	Ref	.098	Ref	.146
<2	776	20.6	2.1 (0.9–4.9)	.004	2.1 (0.8–6.0)	.045
2	370	31.1	3.6 (1.5–8.7)		2.8 (1.0–7.7)	
Computer, h/d						
None	61	13.1	Ref		Ref	
<2	668	20.2	1.7 (0.8–3.6)	.186	0.9 (0.4–2.1)	.836
≥2	472	29.2	2.7 (1.3–5.9)	.010	1.2 (0.5–2.7)	.670
Meets PA guidelines				.083		.852
No	927	24.8	Ref		Ref	
Yes	246	19.5	0.7 (0.5–1.0)		1.0 (0.7–1.4)	
Weight-related characteristics						
BMI percentile					—	—
<85	923	22.8	Ref			
85–94	111	20.7	0.9 (0.6–1.4)	.629		
≥95	65	26.2	1.2 (0.7–2.1)	.529		
Missing	110	30.9	1.5 (1.0–2.3)	.058		
Perceived overweight				.001		.465
No	952	21.6	Ref		Ref	
Yes	244	32.0	1.7 (1.3–2.3)		1.2 (0.8–2.7)	
Trying to lose weight				<.000		.947
No	855	20.5	Ref		Ref	

Downloaded from http://pediatrics.aappublications.org/ by guest on December 12, 2017

TABLE 3 Continued

	n[a]	Exergame, %	OR_{crude} (95% CI)	*P* Value	OR_{adj}[b] (95% CI)	*P* Value
Yes	350	30.9	1.7 (1.3–2.3)		1.0 (0.7–1.5)	
Psychosocial characteristics						
Stress about weight/physical dissatisfaction				<.000		.042
No	899	19.8	Ref		Ref	
Yes	310	34.2	2.1 (1.6–2.8)		1.5 (1.0–2.7)	
Stress about being cut from sports team/organization				.088		.147
No	1088	22.8	Ref		Ref	
Yes	121	29.8	1.4 (1.0–2.2)		1.4 (0.9–2.2)	
Stress about health				.001		.148
No	851	20.8	Ref		Ref	
Yes	358	29.9	1.6 (1.2–2.2)		1.3(1.0–1.8)	
Stress about being accepted by peers				.157		.117
No	1110	23.0	Ref		Ref	
Yes	99	29.3	0.7 (0.5–1.1)		0.7 (0.4–1.1)	
Depression symptoms	2.2 (0.82)	2.4 (0.8)	1.4 (1.2–1.6)	.000	1.1 (0.9–1.4)	.273
Diagnosed mental health disorders						
Anxiety disorder				.131		.355
No	1174	23.2	Ref		Ref	
Yes	35	34.3	1.7 (0.9–3.5)		0.7 (0.3–1.5)	
Eating disorder				.319	—	—
No	1198	23.4	Ref			
Yes	11	36.4	1.9 (0.5–6.5)			
ADHD				.359	—	—
No	1164	23.7	Ref			
Yes	45	17.8	0.7 (0.3–1.5)			

ADHD, attention-deficit/hyperactivity disorder; CI, confidence interval; OR, odds ratio; REF, reference category.

[a] *n* = 1209, totals differ across variables due to missing data.

[b] *n* = 1133, ORs were adjusted for all other variables in the model (ie, those that met the criterion $P < .25$ in univariate analysis).

[c] Age and depression symptoms were tested as continuous variables. — signifies variable was not in final multivariate analysis (i.e. did not meet the criterion P <.25 in univariate analysis)

sample, an additional 27% of exergamers (6% of all participants) played at a light intensity, which may also produce health benefit by decreasing sedentary time.[21,22] Currently youth spend 62% of their waking hours in sedentary activities.[4]

Exergames such as Wii Fit and Dance Dance Revolution in which high amounts of energy are expended[16,32,37,63,64] and which may also contribute to meeting muscle conditioning guidelines,[56] were the most popular exergames. Most exergamers played at home, although many also played at friends' homes. Although exergaming at school is associated with improvements in academic behavior and achievement,[65–67] AdoQuest participants rarely exergamed at school.

Overall these data suggest that exergaming is a popular activity that provides opportunities for adolescents to engage in healthy levels of PA as well as reduce sedentary time. Its popularity may relate to its reliance on technology, easy access at home "on demand," the social interaction integral to many games, the constant feedback on progress toward a goal, being able to try something new, and because, for many people, exergaming is fun.[7,8] Lack of school-based exergaming may represent a "missed opportunity" to introduce young people to another form of PA, as well as to increase the number of opportunities for young people to be physically active.[7]

Although boys are more likely to play nonactive video games,[68] girls were more likely to exergame in this analysis. It is possible that some girls may be uncomfortable exercising at school or in community settings because they feel scrutinized or judged and therefore prefer exercising at home alone or with friends.[69,70] Alternatively, girls may particularly enjoy the social interaction that exergaming provides, which may increase motivation to play.[71] Exergames allow users to create virtual characters to represent themselves on screen, which may also appeal to girls. Finally consoles keep track of progress and provide constant feedback,[7] which may provide a form of motivation that is particularly appealing to girls.

Exergamers were more likely to be stressed about their weight. Adolescents who perceive their weight negatively may enjoy exergaming because it can be done at home with less scrutiny.[29] Alternatively, their parents may encourage them to exergame to lose or manage weight.[72] It is also possible that young people who are stressed about their weight find exergaming a relief from stress and in addition recognize the possible weight loss benefits of exergaming.[44]

Because exergaming is in essence a video game, it is not surprising that

Downloaded from http://pediatrics.aappublications.org/ by guest on December 12, 2017

exergamers were more likely than nonexergamers to engage in nonactive video games and TV viewing. Exergaming may be particularly appealing to youth who are already heavily engaged in screen activities. However, unlike nonactive video games and television, exergaming reduces sedentary screen time, which is negatively associated with obesity.[73–75]

Our results concur with a recent report that youth who play traditional video games are less likely to smoke.[68] It is possible that exergamers spend more time in front of screens and therefore have less time to spend socializing with peers who smoke. Peer smoking is a strong determinant of smoking in youth,[52] and some reports suggest that PA contributes to successful cessation and reductions of nicotine withdrawal symptoms.[76,77] Exergaming may be a useful component of cessation programs targeting young smokers.

Limitations of this analysis include use of self-report data, which may overestimate the prevalence, duration, and intensity of exergaming. The cross-sectional design limits causal inference. Finally, the sample was one of convenience and limited to the Montreal area. This, in addition to loss to follow-up since cohort inception, may limit the external generalizability of the results.

CONCLUSIONS

Many adolescents exergame weekly at intensity levels that may help them achieve current PA recommendations. Although it is well established that boys are more active than girls,[4] girls were more likely to exergame than boys. Exergaming may help increase PA participation and decrease sedentary time in youth and especially in girls.

To maximize the potential of exergaming, interventions should evaluate participant preferences for specific exergames. Although some individuals may not enjoy exergaming at MVPA levels, they may still benefit from exergaming at lighter levels by reducing sedentary behavior.[19,22–25] The feasibility of exergaming in community centers or at school needs to be tested, and research on the sustainability of exergaming is warranted.[19,29,40] Reported barriers to exergaming (ie, boredom, decreases in use over time, technical problems, cost) need to be addressed.[18] Facilitators of exergames (ie, social support, competition, music, experience, new consoles, multiple player modes, contact with players in separate rooms, contact via Internet) hold promise in sustaining exergaming.[34,38,39,42] Replication of these results is warranted to determine if exergaming is a promising PA alternative for girls, as well as to investigate other potential correlates of exergaming.

REFERENCES

1. Katzmarzyk PT, Craig CL, Bouchard C. Original article underweight, overweight and obesity: relationships with mortality in the 13-year follow-up of the Canada Fitness Survey. *J Clin Epidemiol*. 2001;54(9):916–920
2. McIver KL, Brown WH, Pfeiffer KA, Dowda M, Pate RR. Assessing children's physical activity in their homes: the observational system for recording physical activity in children-home. *J Appl Behav Anal*. 2009;42(1):1–16
3. Ogden CL, Carroll MD, Curtin LR, Lamb MM, Flegal KM. Prevalence of high body mass index in US children and adolescents, 2007–2008. *JAMA*. 2010;303(3):242–249
4. Colley RC, Garriguet D, Janssen I, Craig CL, Clarke J, Tremblay MS. Physical activity of Canadian children and youth: accelerometer results from the 2007 to 2009 Canadian Health Measures Survey. *Health Rep*. 2011;22(1):15–23
5. Spinks AB, Macpherson AK, Bain C, McClure RJ. Compliance with the Australian national physical activity guidelines for children: relationship to overweight status. *J Sci Med Sport*. 2007;10(3):156–163
6. Waters E, de Silva-Sanigorski A, Hall BJ, et al. Interventions for preventing obesity in children. *Cochrane Database Syst Rev*. 2011;(12):CD001871
7. Sheehan D, Katz L. The practical and theoretical implications of flow theory and intrinsic motivation in designing and implementing exergaming in the school environment. *J Can Game Studies Assoc*. 2012;6(9):53–68
8. Hansen L, Sanders S. *Exergaming: Combining Video Games, Physical Activity, and Fun*. Fort Worth, TX: American Association of Health Physical Education Recreation and Dance; 2008
9. Witherspoon Hansen L, Sanders SW. Active gaming: a new paradigm in childhood physical activity. *Digital Culture Educ*. 2011; December 11. Available at: www.digitalcultureandeducation.com/uncategorized/dce_1040_hansen_html/. Accessed August 24, 2012
10. Roberts D, Foehr U, Rideout V. Generation M: media in the lives of 8–18 year olds. A Kaiser Family Foundation Study. March 2005. Available at: www.kff.org/entmedia/upload/Executive-Summary-Generation-M-Media-in-the-Lives-of-8-18-Year-olds.pdf. Accessed February 7, 2012
11. Sanders S, Hansen L. *Exergaming: New Directions for Fitness Education in Physical Education* [Anchin Center Policy Brief]. Tampa, FL: Florida University of South; 2008
12. O'Leary KC, Pontifex MB, Scudder MR, Brown ML, Hillman CH. The effects of single bouts of aerobic exercise, exergaming, and videogame play on cognitive control. *Clin Neurophysiol*. 2011;122(8):1518–1525
13. White K, Kilding AE, Schofield G. *Energy Expenditure and Enjoyment During Nintendo Wii Active Video Games: How Do They Compare to Other Sedentary and Physical Activities?* Centre for Physical Activity and Nutrition; Auckland City, New Zealand; 2009
14. Warburton DE, Bredin SS, Horita LT, et al. The health benefits of interactive video game exercise. *Appl Physiol Nutr Metab*. 2007;32(4):655–663
15. Morelli T, Foley J, Lieberman L, Folmer E. Pet-N-Punch: upper body tactile/audio exergame to engage children with visual impairments into physical activity. In: Brooks S, Irani P, eds. Proceedings of Graphics Interface 2011. Waterloo, Canada:

Downloaded from http://pediatrics.aappublications.org/ by guest on December 12, 2017

Canadian Human-Computer Communications Society School of Computer Science, University of Waterloo; 2011:223–230
16. Bailey BW, McInnis K. Energy cost of exergaming: a comparison of the energy cost of 6 forms of exergaming. *Arch Pediatr Adolesc Med*. 2011;165(7):597–602
17. Fogel VA, Miltenberger RG, Graves R, Koehler S. The effects of exergaming on physical activity among inactive children in a physical education classroom. *J Appl Behav Anal*. 2010;43(4):591–600
18. Barnett A, Cerin E, Baranowski T. Active video games for youth: a systematic review. *J Phys Act Health*. 2011;8(5):724–737
19. Biddiss E, Irwin J. Active video games to promote physical activity in children and youth: a systematic review. *Arch Pediatr Adolesc Med*. 2010;164(7):664–672
20. Baranowski T, Buday R, Thompson DI, Baranowski J. Playing for real: video games and stories for health-related behavior change. *Am J Prev Med*. 2008;34(1):74–82
21. Healy GN, Dunstan DW, Salmon J, et al. Objectively measured light-intensity physical activity is independently associated with 2-h plasma glucose. *Diabetes Care*. 2007;30(6):1384–1389
22. Healy GN, Dunstan DW, Salmon J, et al. Breaks in sedentary time: beneficial associations with metabolic risk. *Diabetes Care*. 2008;31(4):661–666
23. Mellecker RR, McManus AM. Energy expenditure and cardiovascular responses to seated and active gaming in children. *Arch Pediatr Adolesc Med*. 2008;162(9):886–891
24. Lanningham-Foster L, Jensen TB, Foster RC, et al. Energy expenditure of sedentary screen time compared with active screen time for children. *Pediatrics*. 2006;118(6). Available at: www.pediatrics.org/cgi/content/full/118/6/e1831
25. DeMattia L, Lemont L, Meurer L. Do interventions to limit sedentary behaviours change behaviour and reduce childhood obesity? A critical review of the literature. *Obes Rev*. 2007;8(1):69–81
26. Lanningham-Foster L, Foster RC, McCrady SK, Jensen TB, Mitre N, Levine JA. Activity-promoting video games and increased energy expenditure. *J Pediatr*. 2009;154(6):819–823
27. Sit CH, Lam JW, McKenzie TL. Direct observation of children's preferences and activity levels during interactive and online electronic games. *J Phys Act Health*. 2010;7(4):484–489
28. Graves LE, Ridgers ND, Williams K, Stratton G, Atkinson G, Cable NT. The physiological cost and enjoyment of Wii Fit in adolescents, young adults, and older adults. *J Phys Act Health*. 2010;7(3):393–401
29. Daley AJ. Can exergaming contribute to improving physical activity levels and health outcomes in children? *Pediatrics*. 2009;124(2):763–771
30. Graf DL, Pratt LV, Hester CN, Short KR. Playing active video games increases energy expenditure in children. *Pediatrics*. 2009;124(2):534–540
31. Graves LE, Ridgers ND, Stratton G. The contribution of upper limb and total body movement to adolescents' energy expenditure whilst playing Nintendo Wii. *Eur J Appl Physiol*. 2008;104(4):617–623
32. Maddison R, Mhurchu CN, Jull A, Jiang Y, Prapavessis H, Rodgers A. Energy expended playing video console games: an opportunity to increase children's physical activity? *Pediatr Exerc Sci*. 2007;19(3):334–343
33. Graves L, Stratton G, Ridgers ND, Cable NT. Comparison of energy expenditure in adolescents when playing new generation and sedentary computer games: cross sectional study. *BMJ*. 2007;335(7633):1282–1284
34. Sell K, Lillie T, Taylor J. Energy expenditure during physically interactive video game playing in male college students with different playing experience. *J Am Coll Health*. 2008;56(5):505–511
35. Tan B, Aziz AR, Chua K, Teh KC. Aerobic demands of the dance simulation game. *Int J Sports Med*. 2002;23(2):125–129
36. Unnithan VB, Houser W, Fernhall B. Evaluation of the energy cost of playing a dance simulation video game in overweight and non-overweight children and adolescents. *Int J Sports Med*. 2006;27(10):804–809
37. Siegel SR, L Haddock B, Dubois AM, Wilkin LD. Active video/arcade games (exergaming) and energy expenditure in college students. *Int J Exerc Sci*. 2009;2(3):165–174
38. Chin A Paw MJ, Jacobs WM, Vaessen EP, Titze S, van Mechelen W, van Mechelen W. The motivation of children to play an active video game. *J Sci Med Sport*. 2008;11(2):163–166
39. Madsen KA, Yen S, Wlasiuk L, Newman TB, Lustig R. Feasibility of a dance videogame to promote weight loss among overweight children and adolescents. *Arch Pediatr Adolesc Med*. 2007;161(1):105–107
40. Maloney AE, Bethea TC, Kelsey KS, et al. A pilot of a video game (DDR) to promote physical activity and decrease sedentary screen time. *Obesity (Silver Spring)*. 2008;16(9):2074–2080
41. Ni Mhurchu C, Maddison R, Jiang Y, Jull A, Prapavessis H, Rodgers A. Couch potatoes to jumping beans: a pilot study of the effect of active video games on physical activity in children. *Int J Behav Nutr Phys Act*. 2008;5:8
42. Paez S, Maloney A, Kelsey K, Wiesen C, Rosenberg A. Parental and environmental factors associated with physical activity among children participating in an active video game. *Pediatr Phys Ther*. 2009;21(3):245–253
43. Foley L, Maddison R. Use of active video games to increase physical activity in children: a (virtual) reality? *Pediatr Exerc Sci*. 2010;22(1):7–20
44. Maddison R, Foley L, Ni Mhurchu C, et al. Effects of active video games on body composition: a randomized controlled trial. *Am J Clin Nutr*. 2011;94(1):156–163
45. Tanaka K, Parker JR, Baradoy G, Sheehan D, Holash JR, Katz L. A comparison of exergaming interfaces for use in rehabilitation programs and research. *J Can Game Stud Assoc*. 2012;6(9):69–81
46. Wiemeyer J, Kliem A. Serious games in prevention and rehabilitation—a new panacea for elderly people? *Eur Rev Aging Phys Act*. 2011;9(1):41–50
47. Lamoth CJ, Caljouw SR, Postema K. Active video gaming to improve balance in the elderly. *Stud Health Technol Inform*. 2011;167:159–164
48. Fitzgerald D, Trakarnratanakul N, Smyth B, Caulfield B. Effects of a wobble board-based therapeutic exergaming system for balance training on dynamic postural stability and intrinsic motivation levels. *J Orthop Sports Phys Ther*. 2010;40(1):11–19
49. Bélanger M, O'Loughlin J, Okoli CT, et al. Nicotine dependence symptoms among young never-smokers exposed to secondhand tobacco smoke. *Addict Behav*. 2008;33(12):1557–1563
50. Ministère de l'éducation du Québec. La carte de la population scolaire et les indices de défavorisation; 2003. Available at: http://www.mels.gouv.qc.ca/sections/publications/publications/SICA/DRSI/bulletin_26.pdf. Accessed August 24, 2012
51. Hammond D, Ahmed R, Yang WS, Brukhalter R, Leatherdale S. Illicit substance use among Canadian youth: trends between 2002 and 2008. *Can J Public Health*. 2011;102(1):7–12
52. O'Loughlin J, Karp I, Koulis T, Paradis G, Difranza J. Determinants of first puff and daily cigarette smoking in adolescents. *Am J Epidemiol*. 2009;170(5):585–597
53. Craig CL, Marshall AL, Sjöström M, et al. International physical activity questionnaire: 12-country reliability and validity. *Med Sci Sports Exerc*. 2003;35(8):1381–1395

Downloaded from http://pediatrics.aappublications.org/ by guest on December 12, 2017

54. Sallis JF, Prochaska JJ, Taylor WC. A review of correlates of physical activity of children and adolescents. *Med Sci Sports Exerc*. 2000;32(5):963–975
55. Brener ND, Billy JO, Grady WR. Assessment of factors affecting the validity of self-reported health-risk behavior among adolescents: evidence from the scientific literature. *J Adolesc Health*. 2003;33(6):436–457
56. Canadian Society for Exercise Physiology ParticipACTION. Canadian Physical Activity guidelines; 2010. Available at: www.csep.ca/CMFiles/Guidelines/CSEP-InfoSheets-youth-ENG.pdf. Accessed February 7, 2012
57. Canadian Society for Exercise Physiology ParticipACTION. Canadian Sedentary Behaviour Guidelines, 2010; 2011. Available at: www.csep.ca/CMFiles/Guidelines/CSEP-InfoSheets-ENG-Teen%20FINAL.pdf. Accessed February 7, 2012
58. Centers for Disease Control and Prevention. A SAS program for the CDC Growth Charts. Available at: www.cdc.gov/nccdphp/dnpao/growthcharts/resources/sas.htm. Accessed February 7, 2012
59. Kandel DB, Davies M. Epidemiology of depressive mood in adolescents: an empirical study. *Arch Gen Psychiatry*. 1982;39(10):1205–1212
60. Choi WS, Patten CA, Gillin JC, Kaplan RM, Pierce JP. Cigarette smoking predicts development of depressive symptoms among U.S. adolescents. *Ann Behav Med*. 1997;19(1):42–50
61. Hosmer DW, Lemeshow S. *Applied Logistic Regression*. 2nd ed. New York, NY: John Wiley & Sons; 2000
62. World Health Organization (WHO). Global recommendations on physical activity for health. Geneva, Switzerland: WHO Press; 2010. Available at: http://whqlibdoc.who.int/publications/2010/9789241599979_eng.pdf. Accessed February 7, 2012
63. Miyachi M, Yamamoto K, Ohkawara K, Tanaka S. METs in adults while playing active video games: a metabolic chamber study. *Med Sci Sports Exerc*. 2010;42(6):1149–1153
64. Yang SP, Graham GM. Exergames: being physically active while playing video games. *Biann Bull Hellenic Acad Phys Educ*. 2006;4:5–6
65. Young TL. *"U Got 2 Move It" Pilot Study: Impact of an After-School Interactive Video Exertainment Program for Underserved Children* [doctoral dissertation]. Loma Linda, CA: Loma Linda University, School of Public Health; 2007
66. Hellmich N. Go to school and just dance: video games and other activities supplement gym class. *USA Today*, May 2, 2010. Available at: www.usatoday.com/printedition/life/20101011/justdance11_cv.art.htm. Accessed February 8, 2012
67. Staiano AE, Calvert SL. Exergames for physical education courses: physical, social, and cognitive benefits. *Child Dev Perspect*. 2011;5(2):93–98
68. Desai RA, Krishnan-Sarin S, Cavallo D, Potenza MN. Video-gaming among high school students: health correlates, gender differences, and problematic gaming. *Pediatrics*. 2010;126(6). Available at: www.pediatrics.org/cgi/content/full/126/6/e1414
69. Robbins LB, Pender NJ, Kazanis AS. Barriers to physical activity perceived by adolescent girls. *J Midwifery Womens Health*. 2003;48(3):206–212
70. Dwyer JJ, Allison KR, Goldenberg ER, Fein AJ, Yoshida KK, Boutilier MA. Adolescent girls' perceived barriers to participation in physical activity. *Adolescence*. 2006;41(161):75–89
71. Suhonen K, Väätäjä H, Virtanen T, Raisamo R. Seriously fun: exploring how to combine promoting health awareness and engaging gameplay. In: *Proceedings of the 12th International Conference on Entertainment and Media in the Ubiquitous Era*, MindTrek '08, October 7–9, 2008; Tampere, Finland. New York, NY: ACM
72. Ludwig DS. Weight loss strategies for adolescents: a 14-year-old struggling to lose weight. *JAMA*. 2012;307(5):498–508
73. Ballard M, Gray M, Reilly J, Noggle M. Correlates of video game screen time among males: body mass, physical activity, and other media use. *Eat Behav*. 2009;10(3):161–167
74. Padilla-Walker LM, Nelson LJ, Carroll JS, Jensen AC. More than a just a game: video game and internet use during emerging adulthood. *J Youth Adolesc*. 2010;39(2):103–113
75. Hohepa M, Scragg R, Schofield G, Kolt GS, Schaaf D. Associations between after-school physical activity, television use, and parental strategies in a sample of New Zealand adolescents. *J Phys Act Health*. 2009;6(3):299–305
76. Horn K, Dino G, Branstetter SA, et al. Effects of physical activity on teen smoking cessation. *Pediatrics*. 2011;128(4). Available at: www.pediatrics.org/cgi/content/full/128/4/e801
77. Ussher MH, Taylor A, Faulkner G. Exercise interventions for smoking cessation. *Cochrane Database Syst Rev*. 2008;(4):CD002295

Downloaded from http://pediatrics.aappublications.org/ by guest on December 12, 2017

Prevalence and Correlates of Exergaming in Youth

Erin K. O'Loughlin, Erika N. Dugas, Catherine M. Sabiston and Jennifer L. O'Loughlin

Pediatrics originally published online October 1, 2012;

Updated Information & Services	including high resolution figures, can be found at: http://pediatrics.aappublications.org/content/early/2012/09/26/peds.2012-0391
Permissions & Licensing	Information about reproducing this article in parts (figures, tables) or in its entirety can be found online at: https://shop.aap.org/licensing-permissions/
Reprints	Information about ordering reprints can be found online: http://classic.pediatrics.aappublications.org/content/reprints

Pediatrics is the official journal of the American Academy of Pediatrics. A monthly publication, it has been published continuously since . Pediatrics is owned, published, and trademarked by the American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, Illinois, 60007. Copyright © 2012 by the American Academy of Pediatrics. All rights reserved. Print ISSN: .

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN™

Downloaded from http://pediatrics.aappublications.org/ by guest on December 12, 2017

PEDIATRICS®
OFFICIAL JOURNAL OF THE AMERICAN ACADEMY OF PEDIATRICS

Prevalence and Correlates of Exergaming in Youth

Erin K. O'Loughlin, Erika N. Dugas, Catherine M. Sabiston and Jennifer L. O'Loughlin

Pediatrics originally published online October 1, 2012;

The online version of this article, along with updated information and services, is located on the World Wide Web at:
http://pediatrics.aappublications.org/content/early/2012/09/26/peds.2012-0391

Pediatrics is the official journal of the American Academy of Pediatrics. A monthly publication, it has been published continuously since . Pediatrics is owned, published, and trademarked by the American Academy of Pediatrics, 141 Northwest Point Boulevard, Elk Grove Village, Illinois, 60007. Copyright © 2012 by the American Academy of Pediatrics. All rights reserved. Print ISSN: .

American Academy of Pediatrics
DEDICATED TO THE HEALTH OF ALL CHILDREN™

Downloaded from http://pediatrics.aappublications.org/ by guest on December 12, 2017