

The Association Between Exercise Behavior Regulation and Exergaming in Adolescents

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Background: It is not known if or how exercise behavior regulations (EBRs) relate to exergaming in adolescents. The study objectives were 1) to determine if EBRs differ between adolescents who do and do not exergame; and 2) among exergamers, to describe the associations between EBRs and exergame duration, intensity, and achieving physical activity (PA) guidelines. **Methods:** This study was a cross-sectional analysis of data collected in mailed self-report questionnaires completed by 1243 students (mean $\pm$ SD_{age} = 16.8 $\pm$ 0.5 years; 43% boys). **Results:** In girls, those who exergamed scored higher than nonexergamers on introjected (mean $\pm$ SD = 1.9 $\pm$ 1.0 vs. 1.6 $\pm$ 0.9; P = .001) and identified (mean $\pm$ SD = 3.1 $\pm$.0 vs. 2.9 $\pm$ 0.9; P = .049) regulation. Exergame intensity was associated with identified regulation [OR (95% CI) = 2.2 (1.0, 4.5)], minutes exergaming per week was associated with amotivation [β (95% CI) = 0.4 (–0.0, 0.8)], and achieving guidelines was associated with external [OR (95% CI) = 3.7 (1.0, 13.4)] and identified [OR (95% CI) = 5.6 (2.0, 16.0)] regulations. In boys who exergamed, intrinsic regulation was associated with exergame duration [β (95% CI) = –0.3 (–0.6, 0.0)]. **Conclusions:** Girls who exergame may have partially internalized exergaming as a PA behavior. Boys may prefer other types of PA such as team sports or other more traditional videogames over exergaming or they may not view exergaming as PA.

Keywords: active video games, adolescence, physical activity, self-determination theory

Physical activity (PA) is associated with numerous health benefits, yet few adolescents meet current PA recommendations of 60 minutes of moderate-to-vigorous intensity PA daily.^{1,2} It is critical that effective strategies to increase and sustain healthy PA levels in adolescents are identified. Positive PA experiences in school, at home and in community settings may foster an internal desire or motivation to sustain PA participation simply for its challenges or for enjoyment.³ Exergaming, a type of active video-gaming, offers a PA alternative that may increase motivation to be active and be effective in increasing PA in adolescents.^{3–5}

Exergaming is becoming increasingly popular among adolescents, and has been described as a highly enjoyable activity which adolescents may sustain over time.^{6,7} Desirable features include its adaptability to multiple skill levels, its self-learning tutorials, the individualized nature of the games, the autonomous playing schedules, the ability to play with or without others and the independence from sport instruction and skill level.⁸ Exergaming may enhance perceptions of autonomy, mastery and competence^{9,10} by providing choice in games to play and the option to improve (timing for example), master (a specific skill for example) or move up a level in the game (from beginner to intermediate for example).⁹ Exergames can be played in a variety of settings^{11,12} thereby increasing

opportunities for adolescents to participate in PA^{13,14} and to decrease sedentary behavior.^{11,15}

The primary objectives of exergaming studies to date have been to describe energy expended during exergaming,^{16–19} to compare exergaming energy expenditure to that of more traditional forms of PA,¹⁹ to test the effects of exergaming behavior over time,^{20,21} to evaluate exergaming as a method to increase PA in adolescents,^{22–24} and to test the effects of exergaming on rehabilitation.^{25,26} In addition, the determinants of exergaming have recently been identified in a population-based sample of adolescents.²⁷ Although informative, these studies are rarely guided by theoretical perspectives that could provide useful interpretive and practical frameworks. More specifically, use of theory may provide clues about what motivates adolescents to exergame as well as about modifiable mechanisms underpinning the behavior that can be targeted in interventions for PA promotion and planning.^{11,28}

The Self-Determination Theory (SDT) is used to explain why people adopt and maintain healthy behaviors²⁹ such as exercise and PA participation.³⁰ Broadly defined, SDT is a macro theory comprised of 5 mini-theories that explain intrinsic motivation, extrinsic motivation, individual differences in environmental orientations, basic psychological needs (relatedness, competence, and autonomy), goal content and achievement.³¹ Of interest to the current study, the Organismic Integration Theory (OIT)³¹ defines motivation as a self-determined continuum ranging from amotivation (ie, an individual lacks a sense of intention to participate) at the one end, extrinsic motivation (ie, a drive that is determined by external factors such as rewards or to avoid punishment) in the middle, and intrinsic motivation (ie, a drive within the individual that is determined by interest or enjoyment in the task) at the most self-determined extreme. Extrinsic motivation is further differentiated as 4 regulations, or reasons for exercise, that range in level of self-determination and internalization. Specifically, external regulation is described as when an individual's behavior(s) is controlled

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by constraints or incentives and participation is to satisfy external demands. Introjected regulation is characterized by behaviors that are reinforced by internal pressures or to avoid guilt, ego threat or shame. Identified regulation is characterized by behaviors that are thought to be important and are done willingly, yet still for extrinsic reasons. Integrated regulation, the most self-determined form of extrinsic motivation, is characterized by performing activities that are personally important to the individual and are directed toward a valued outcome.²⁹ Integrated regulation is not often studied in the context of OIT given limited measurement scales to assess this regulation. Intrinsic motivation is associated with increased duration, intensity and enjoyment of PA^{32,33} as well as greater intentions to engage in exercise behavior.^{34,35} Nonetheless, some studies have reported identified regulation is a stronger predictor of PA than intrinsic motivation, suggesting that individuals need to feel PA is important but may not completely enjoy participating in PA.³⁴ Finally, although not all studies support the premise,³⁶ exercise behavior regulations (EBRs) and their relationship to PA may differ by sex.^{37,38}

Although previously examined in mostly clinical populations and adults,^{25,39} the association between EBRs and exergaming has rarely been investigated in adolescent boys and girls. Therefore it is unknown if EBRs differ between young exergamers and non-exergamers. As the popularity of exergaming grows, increased understanding of the association between EBRs and exergaming may inform interventions to promote exergaming by examining the motivations underpinning the behavior.⁴⁰ Using OIT as a conceptual framework, the objectives of this study were to examine if EBRs differ between adolescents who do and do not exergame, and in exergamers, to investigate if EBRs relate to exergame duration, exergame intensity or achieving moderate-to-vigorous PA (MVPA) guidelines. It was hypothesized that 1) exergamers have higher identified and intrinsic regulations than nonexergamers; and that 2) more self-determined EBRs are associated with increased duration and higher intensity of exergaming, as well as with achieving MVPA guidelines.^{25,37}

Methods

Data were drawn from AdoQuest, a prospective cohort investigation of 1843 students aged 10 to 12 years at inception. This study was designed to investigate the natural course of health-compromising behaviors in adolescents. Participants were recruited in a stratified random sample of schools selected from all French-language schools with more than 90 grade 5 students in the greater Montreal area (Quebec, Canada). Detailed information on the design and methods of AdoQuest is available.^{27,41} Ethics approval was provided by the Centre de Recherche du Centre Hospitalier de l'Université de Montréal.

This current cross-sectional analysis uses data collected in 2010–11 when participants were aged 14 to 19 years and in grade 10 or 11. Data on sociodemographic characteristics, EBRs, exergame use, height and weight, and PA were collected in mailed self-report questionnaires completed by 1243 of the 1843 participants (67%). Data on mother's education were collected in mailed self-report questionnaires completed in 2006 and/or 2009 by 1435 parents of AdoQuest participants (78% of those eligible).

Study Variables

Sociodemographic variables included sex, currently employed (yes, no) and Caucasian (yes, no). Data on self-report height and weight

were used to compute BMI as weight (kg)/ height (m²). Data on whether mothers were university-educated (yes, no) were drawn from the parent questionnaire.

PA was measured using the short-form International Physical Activity Questionnaire, which demonstrates reliability and validity against the accelerometer data.⁴² 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: "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 vigorous and moderate PA were summed to create MVPA scores. Participants were categorized as achieving MPVA guidelines¹ if they reported ≥ 420 minutes of MVPA per week.

Exergaming participation was measured by: "Do you play active video games (ex: Wii Fit®, Dance Dance Revolution®)?" (yes, no). Those who responded "yes" were asked

"How many days a week do you play active video games?" (1 to 7 days)

"How many minutes on average do you play each session?" (open-ended)

"Please indicate your usual level of effort during play" (response choices: light, moderate, vigorous).

Exergame duration was calculated by multiplying number of days per week by usual minutes per bout; the variable thus created was transformed using a $\ln$ function, since the distribution of the scores was nonnormal. Exergame intensity was dichotomized as moderate-to-vigorous or light.

EBRs were measured using the 19-item Behavioral Regulation in Exercise Questionnaire (BREQ-2)⁴³ which assesses amotivation, external regulation, introjected regulation, identified regulation, and intrinsic motivation. Participants responded to each item on a 5-point Likert scale ranging from 0 (not true for me) to 4 (very true for me). The multidimensional structure of the BREQ-2 has been confirmed⁴⁴ and the items demonstrate internal consistency ($\alpha = .67$ to 0.83).^{33,44–46} Due to nonnormality, amotivation scores were dichotomized yes (any indication of amotivation) or no (no indication of amotivation) for analyses. All other EBRs were retained as continuous variables.

Data Analysis

Congruent with previous literature^{37,47} and preliminary analyses showing a significant sex $\times$ EBR interaction, all analyses were stratified by sex. Significant differences between boys and girls who did and did not exergame on any of the EBRs were tested in one way ANOVAs (one model for each gender). The associations between EBRs and each outcome [exergame duration (minutes per week); exergame intensity (low, moderate-vigorous)] were examined in multivariate linear or logistic regression controlling for covariates associated with PA including age and BMI. Employment was also included as a covariate since it may result in lack of time for PA or exergaming. MVPA was included as a covariate in the models testing the association between EBRs and exergaming outcomes. The association between EBRs and achieving MVPA guidelines was tested in 2 separate logistic regression models stratified by sex and

controlling for age, BMI, and employment. Participants missing data on the outcome variables and/or covariates were not included in the analyses. All statistical tests were double-sided, with a significance level of 0.05. All analyses were conducted in SPSS version 18.

Results

The mean $\pm$ 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. Compared with participants not retained for analysis ($n = 636$), a higher proportion of those retained ($n = 1209$) were girls (55% vs. 45%; $P = .003$), they were younger at baseline (mean $\pm$ SD age = 10.7 ± 0.5 vs. 10.8 ± 0.6 ; $P < .001$) and a higher proportion had a mother

who was university-educated (32% vs. 25%; $P = .010$). Almost one-quarter of participants reported exergaming, including 29% of girls and 17% of boys ($P < .001$). EBR information was available for 1186 of the 1243 participants (95%); those with EBR data did not differ significantly from those who did not provide EBR data.

EBRs in Exergamers and Nonexergamers

There were no significant differences between boys who did and did not exergame on any of the EBR scores (Figure 1). Introjected (mean $\pm$ SD = 1.9 ± 1.0 vs. 1.6 ± 0.9 ; $P = .001$) and identified (mean $\pm$ SD = 3.1 ± 1.0 vs. 2.9 ± 0.9 ; $P = .049$) EBRs were significantly higher in girls who exergamed compared with girls who did not exergame (Figure 1).

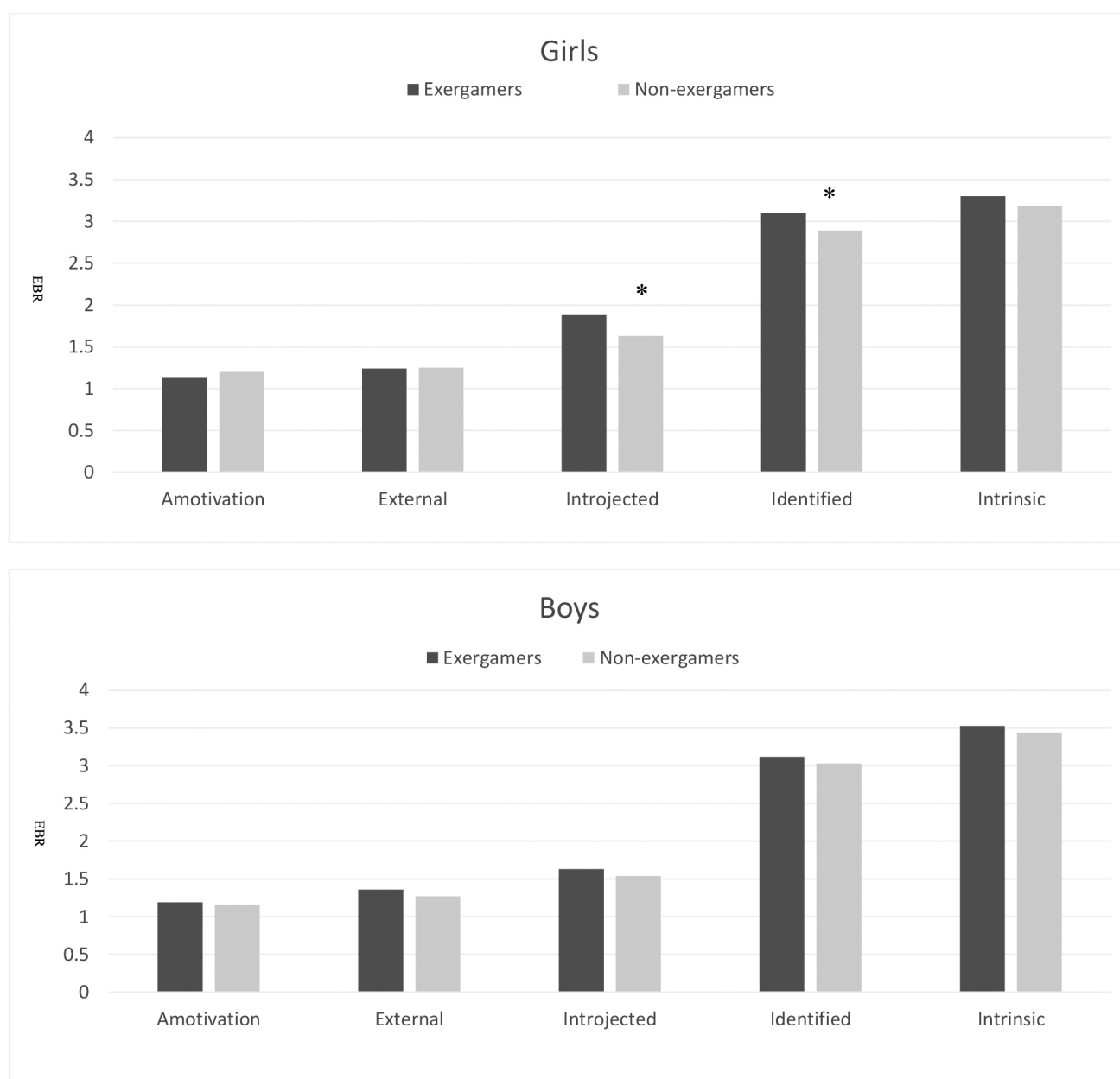


Figure 1 — Mean score for amotivation, external, introjected, identified, and intrinsic regulation in exergamers and nonexergamers by sex. * $p < 0.05$.

EBRs in Exergamers

Girls who exergamed scored higher than boys who exergamed on introjected regulation (mean $\pm$ SD = 1.9 ± 1.0 vs. 1.6 ± 0.8 ; $P = .040$).

Exergame Duration

Among adolescents who exergamed, the mean number of minutes exergaming per week was significantly higher in boys than girls (mean $\pm$ SD = 137.3 ± 162.5 and 92.1 ± 128.7 , respectively; $P = .024$). In multivariate analyses controlling for age, employment, BMI, and achieving MVPA guidelines (Table 1), intrinsic regulation was negatively associated with exergame duration in boys [β (95% CI) = -0.3 ($-0.6, 0.0$), $P = .057$] and amotivation was associated with minutes exergaming per week among girls [β (95% CI) = 0.4 ($-0.0, 0.8$), $P = .054$].

Exergame Intensity

Twenty-seven percent of exergamers reported that they exergamed at light intensity, 57% exergamed at moderate intensity, and 16% exergamed at vigorous intensity, with no significant differences between boys and girls ($P = .924$). None of the EBRs were significantly associated with exergame intensity in boys, while identified regulation was positively associated with exergame intensity in girls [OR (95% CI) = 2.2 ($1.0, 4.5$), $P = .042$; Table 1].

MVPA Guidelines

Overall, 20% of AdoQuest participants met MVPA guidelines, with no significant difference between exergamers and nonexergamers (18% and 22%, respectively; $P = .148$). Almost 12% of girls and 32% of boys who exergamed met MVPA guidelines ($P < .001$). Boys reported a mean $\pm$ SD of 408.6 ± 465.8 minutes of MVPA per week; girls reported a mean $\pm$ SD of 219.4 ± 252.8 minutes of MVPA per week ($P = .001$). None of the EBRs were significantly associated with achieving MVPA recommendations in boys (Table 1). External [OR (95% CI) = 3.7 ($1.0, 13.4$), $P = .048$] and identified regulation [OR (95% CI) = 5.6 ($2.0, 16.0$), $P = .001$] were both significantly associated with achieving MVPA guidelines in girls.

Discussion

The purpose of this study was 1) to determine if EBRs differ between adolescents who do and do not exergame; and 2) among exergamers, to describe the associations between EBRs and exergame duration, exergame intensity (light versus moderate-vigorous), and achieving MVPA guidelines. Consistent with our hypothesis, girls who exergamed scored higher on identified regulation than nonexergamers. These results concord with those of Osorio et al, who reported that exergamers scored higher on introjected and identified regulation toward exergaming compared with participants who described their EBRs toward exercise 'traditional' PA.³⁹ They proposed that performing light intensity exercise while also playing a computer

Table 1 Odds Ratio (OR) and 95% Confidence Intervals (CI) for the Association Between EBRs and Exergame Intensity, and EBRs and Achieving Moderate-to-Vigorous Physical Activity (MVPA) Guidelines, and Unstandardized Beta Coefficients (β) (95% CI) for the Association Between EBRs and Minutes Exergaming per Week in Boys and Girls

	Exergame intensity ^{b,e}		Minutes exergaming ^{a,e} per week		Met MVPA guidelines ^{d,f}	
	OR (95% CI)	P-value	β (95% CI)	P-value	OR (95% CI)	P-value
Boys (n = 90)*						
Exercise behavior regulation						
Amotivation ^c	1.5 (0.3, 6.9)	0.599	-0.0 (-0.7, 0.6)	0.925	0.6 (0.1, 3.6)	0.543
External	0.7 (0.2, 2.4)	0.587	-0.4 (-0.8, 0.1)	0.152	0.2 (0.0, 1.3)	0.090
Introjected	2.1 (0.7, 6.0)	0.162	-0.1 (-0.4, 0.2)	0.560	0.9 (0.4, 2.3)	0.854
Identified	1.4 (0.5, 4.2)	0.527	-0.0 (-0.4, 0.4)	0.955	2.0 (0.7, 5.6)	0.199
Intrinsic	0.7 (0.3, 1.4)	0.278	-0.3 (-0.6, 0.0)	0.057	1.4 (0.6, 3.0)	0.438
Girls (n = 201)*						
Exercise behavior regulation						
Amotivation ^c	1.4 (0.5, 4.3)	0.539	0.4 (-0.0, 0.8)	0.054	0.6 (0.1, 5.8)	0.617
External	1.1 (0.4, 3.1)	0.834	0.1 (-0.3, 0.5)	0.699	3.7 (1.0, 13.4)	0.048
Introjected	0.8 (0.5, 1.3)	0.389	0.0 (-0.2, 0.2)	0.716	0.7 (0.4, 1.3)	0.278
Identified	2.2 (1.0, 4.5)	0.042	0.2 (-0.1, 0.5)	0.124	5.6 (2.0, 16.0)	0.001
Intrinsic	1.0 (0.6, 1.7)	0.944	-0.2 (-0.3, 0.0)	0.111	1.2 (0.6, 2.4)	0.566

^a Because of nonnormality, minutes exergaming per week was normalized on the $\ln$ scale.

^b Light vs. moderate and intense bouts.

^c Amotivation ≥ 1 vs. < 1 (ref ≤ 1).

^d Met MVPA guidelines of ≥ 420 minutes per week.

^e Controlled for age, BMI, achieving MVPA guidelines and employment

^f Controlled for age, BMI and employment.

* n may differ due to missing data on covariates.

game encouraged participation in exergaming.³⁹ However introjected regulation scores were also higher among girls in the current study. Based on OIT tenets,³⁰ introjected regulation is a 'gateway' to internalization⁴⁹ and self-determination and therefore may play a role in how adolescent girls adopt and sustain activities such as exergaming. It may be that girls who exercise for introjected reasons (ie, to manage emotions, feeling of guilt when they do not exercise, to protect identity) view exergaming as an opportunity to exercise at home in a comfortable environment, which helps overcome common PA barriers while maintaining external reasons for exercise.

Among girls who exergamed, both identified and external regulations were associated with achieving MVPA guidelines. Based on previous reports, a positive association between the more self-determined extrinsic motivations and MVPA was anticipated.⁵⁰ In fact, identified regulation is often a stronger correlate of PA than intrinsic motivation.⁵⁰ While inconsistent with OIT and SDT perspectives, some health behaviors such as PA may not be inherently enjoyable or interesting and therefore intrinsic motivation is challenging to study and to modify. The association between EBRs and achieving PA guidelines was unexpected. It may be that girls who exergame do so because of external regulations (ie, many exergames focus on developing skills for fitness and weight change)⁵¹ and exergames may continue to foster external regulations given their focus on weight and body shape coupled with the immediate feedback often integrated into exergaming systems (ie, body weight, body alignment, placement, etc. are captured by motion sensors and displayed in real-time on the screen). As such, girls may report higher levels of extrinsically-contingent MVPA while also expressing the importance and value of MVPA as demonstrated by the positive association between identified regulation and MVPA.

As hypothesized, identified regulation was positively associated with exergaming intensity in girls. Girls may have initiated the process of internalizing PA and developing more self-determined motives^{49,52} and therefore exergamed at higher intensities. A possible reason for this internalization could be enjoyment of the activity. Lyons et al found that among overweight young adults, exergames that are more enjoyable and engaging may produce higher playing intensities.⁵³ In addition, Sell et al found that in a sample of college students, intensity level was higher in experienced versus nonexperienced players.⁵⁴ Girls may choose to play exergames that they really enjoy and, as they gain experience, increase playing intensity. It is also possible that external reasons (ie, to maintain or lose weight, to attain other health benefits) were the initial motives for exergaming, yet because of enjoyment, the behavior became internalized. Although exergaming promotes weight loss in adolescent girls,⁵¹ PA interventions should include components such as enjoyment and mastery found through exergaming that foster internalizing PA behavior.^{36,40,54} In addition playing a variety of different games has been associated with higher exergaming intensities.²⁸

Contrary to our hypothesis and to OIT and SDT tenets, intrinsic behavior regulation was negatively associated with exergame duration in boys. In addition, girls who reported amotivation reported more time exergaming per week. It may be that girls, who are not motivated toward traditional PA such as team sports, spend more time exergaming. It is possible that boys prefer traditional videogames over exergaming⁵⁵ especially if they do not view exergaming as PA or prefer to be sedentary when playing videogames. Motivation for traditional video games may be more external (ie, external regulation) since gamers tend to participate to gain acknowledgment or acceptance from a social group.³⁹ In addition, White et al reported that the nonactive time during many exergames may reduce the

psychological impact of the game in adolescent boys.⁵⁶ Rather than viewing exergaming as a replacement for more traditional forms of PA, exergaming interventions targeting boys could focus on adding to duration of current PA and decreasing sedentary behaviors to increase overall PA time.

The main limitations of this study include the cross-sectional design which limits causal inference, and the self-report data which may be subject to misclassification. In particular, if participants were unfamiliar with PA terminology, intensity of exergaming (light, moderate-to-vigorous) may have been misclassified. Our MVPA indicator may have included time spent exergaming and, although exergaming may be considered a type of PA, the EBR measures were not specific to exergaming. The sample was one of convenience which, in addition to loss to follow-up since inception, may limit generalizability of the results.

This study investigated the association between EBRs and exergaming within an OIT framework. However, there are other many mini-theories within SDT that warrant investigation. For example, the association between basic psychological needs (eg, competence, autonomy, relatedness), EBRs, and exergaming behavior should be investigated. Understanding the underlying goal content of exergaming participation may also be of interest. Song et al found that the amount of competition in exergames was related to positive gaming experiences, and depending on if an individual is competitive or not, the game may affect intrinsic motivation (ie, if the game was too competitive it could have detrimental effects on a noncompetitive person making the experience less enjoyable).⁵⁷

Conclusion

To our knowledge, this is one of the first studies to incorporate a theoretical perspective in examining the association between EBR and exergaming in adolescents. While there were no differences in EBRs in boys, EBRs differed in girls who do and do not exergame. In addition, EBRs were associated with exergaming duration and intensity, although these relationships appear to differ by sex. Further EBRs may differ in boys and girls who exergame. If these findings are replicated, exergaming interventions may need to adapt components such as game choice, duration, and intensity to each sex to promote positive PA behavior. However, irrespective of sex, exergaming interventions for adolescents should encourage intrinsic goals such as enjoyment and challenge.^{9,10}

Acknowledgments

This work was supported by the Canadian Cancer Society (grant 15689) and the Institut national de santé publique du Québec (INSPQ). JOL holds a Canada Research Chair in the Early Determinants of Adult Chronic Disease. EOL is funded by the Foundation CHU Sainte-Justine. Authors thank the AdoQuest participants for their participation.

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