

The Association Between Exergaming and Physical Activity in Young Adults

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Background: Compared with traditional nonactive video games, exergaming contributes significantly to overall daily physical activity (PA) in experimental studies, but the association in observational studies is not clear. **Methods:** Data were available in the 2011 to 2012 wave of the Nicotine Dependence in Teens (NDIT) study ($N = 829$). Multivariable sex-stratified models assessed the association between exergaming (1–3 times per month in the past year) and minutes of moderate and vigorous physical activity in the previous week, and the association between exergaming and meeting PA recommendations. **Results:** Compared with male exergamers, female exergamers were more likely to believe exergames were a good way to integrate PA into their lives (89% vs 62%, $P = .0001$). After we adjusted for covariates, male exergamers were not significantly different from male nonexergamers in minutes of PA. Female exergamers reported 47 more minutes of moderate PA in the previous week compared with female nonexergamers ($P = .03$). There was no association between exergaming and meeting PA recommendations. **Conclusions:** Exergaming contributes to moderate minutes of PA among women but not among men. Differences in attitudes toward exergaming should be further explored.

Keywords: active video games, exergaming, young adults, physical activity

Less than 15% of 20- to 39-year-old young adults meet the recommendation of the American College of Sports Medicine (ACSM) and the Canadian Society for Exercise Physiology (CSEP) of 150 minutes of moderate-to-vigorous physical activity (PA) per week.^{1,2} Moreover, nearly half of all Canadian adults spend ≥ 2 hr/day engaged in screen time or other sedentary behaviors.³ Strategies are needed to help increase PA and decrease sedentary behaviors among Canadian adults.

In contrast to traditional video games, active-play video games (“exergames”) require that participants be physically active to advance in the game. Exergaming can significantly increase energy expenditure above resting rates,^{4–10} thus possibly contributing to meeting PA recommendations. Although research suggests that exergaming contributes significantly to weekly PA recommendations compared with traditional nonactive video games,^{11–13} most data in this realm are from experimental studies in select samples of limited size.^{14–17} Few observational studies have assessed how

exergaming contributes to PA. Although an estimated 25% to 40% of children play exergames,^{18,19} the prevalence of exergaming in young adults and the likelihood that exergaming contributes significantly to PA among young adults is unknown. Thus, the aim of the current study was to improve our understanding of exergaming use in young adults.

Specifically, the objectives of this observational study of young adults were (1) to describe exergaming use and attitudes toward exergaming according to demographic characteristics, (2) to assess differences in PA between exergamers and nonexergamers, and (3) to assess whether total minutes of PA per week among exergamers differs from that of nonexergamers and whether exergamers were more likely to meet the ACSM and CSEP guidelines.

Methods

Participants were from the Nicotine Dependence in Teens (NDIT) Study, a longitudinal cohort study investigating the natural history of nicotine dependence in youth. The sampling frame and study design details have been described previously.²⁰ In brief, 1294 participants from a convenience sample of 10 secondary schools in Montreal, Canada, were recruited in 1999 when they were approximately 12 years of age. Data were collected every 3 months from 1999 to 2005 (survey cycles 1 to 20) and every 3 years thereafter. Measures of exergaming behavior were added to the mailed self-report questionnaire in the 22nd data collection cycle in 2011 to 2012, when participants were approximately 24 years of age. All study participants provided informed consent, and the study was approved by the Ethics Review Board of the Centre de Recherche du Centre Hospitalier de l'Université de Montréal. Analyses were restricted to participants with no missing data on PA and exergaming use ($N = 829$).

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Study Variables

Exergaming was measured with the item, “In the past 12 months, how often did you play physically active video games (ex. Wii, Dance Dance Revolution)?” Response choices included “never,” “less than once a month,” “1–3 times per month,” “1–6 times per week,” and “every day.” Participants who reported playing exergames at least 1 to 3 times per month in the past year were categorized as exergamers. Those who reported no exergaming or exergaming less than once per month in the past year were categorized as nonexergamers. Average exergaming minutes per week in the past month and perceived levels of intensity of exergaming were also reported. In addition to frequency, participants provided data on whether they preferred exergames to indoor/outdoor sports, and whether they felt that exergaming was a good way to integrate PA into their lives. Responses were measured on a 3-point Likert scale (“not at all true,” “a bit true,” “very true”). For analysis, responses were recoded as “very true” compared with “not at all true” or “a bit true.” Participants also indicated which exergames they had played from a list of 11 exergaming genres (such as Boxing or Dance Dance Revolution); these games were grouped into 4 mutually exclusive categories: fitness-training (such as EA Active), dance (such as Dance Dance Revolution), martial arts or boxing (such as Punchout) or a sports simulation game (such as Wii Sports). Participants were also asked whether these games were played in their homes or at a friend’s home.

PA was measured using the International Physical Activity Questionnaire (IPAQ), which has been validated among adults.²¹ To calculate weekly minutes of PA, we asked the participants the number of days in the previous week, and number of minutes per bout, on which they had engaged in moderate PA such as “carrying light loads, bicycling at a regular pace, doubles tennis” and vigorous PA such as “heavy lifting, digging, aerobics, fast bicycling.” Participants were instructed to include only activities that were undertaken for at least 10 minutes at a time, and to exclude walking, which was assessed in a separate question. The total minutes of moderate and vigorous PA were summed to produce total minutes of *moderate-to-vigorous physical activity* (MVPA). Participants were considered to have met the ACSM and CSEP guidelines for PA if they reported a minimum of 150 minutes of moderately intense PA, a minimum of 75 minutes of vigorously intense PA, or a combination of both for at least 150 minutes in the previous week. Reported minutes of PA ≥ 180 /day were truncated in accordance with IPAQ recommendations.²²

Covariates included sociodemographic characteristics such as age, whether the participant had an annual income $< \$20,000$ CAN, whether the participant was employed part-time or full-time, whether the participant had completed high school, and other factors that may relate to PA,²³ such as whether the participant was overweight or obese on the basis of body mass index (BMI) calculations and whether the participant’s television or computer screen time was ≥ 2 hr/day in the previous week.²⁴ BMI was calculated on the basis of the average of 2 measurements of height and weight collected by trained study staff. All other covariates were based on self-report.

Data Analysis

All analyses were performed with SAS 9.2; t tests and χ^2 tests were used for comparison of sociodemographic characteristics. Multivariable linear regression was used to assess the association between exergaming and moderate, vigorous, or MVPA minutes in the previous week. Multivariable logistic regression was used to

assess the association between exergaming and meeting the ACSM and CSEP guidelines. In multivariable analyses, dummy variables were used for the approximately 10% of missing covariate data on income, weight status or screen time. Use of dummy variables enabled analyses to be conducted using the full sample and to determine whether missing data were related to PA. Sensitivity analyses among participants with complete data did not affect our results (data not shown). Because PA is higher among men than women,²⁵ and exergaming is more common among women,^{16,19} the objectives were assessed in sex-stratified analyses.

Results

Compared with the participants excluded from the analysis due to missing PA or exergaming data, a higher proportion of the study sample was female (55% vs 46%; $P = 0.03$). There were no other significant differences.

Approximately 18% of men and women in the study sample were exergamers (Table 1). There were no significant differences between male exergamers and male nonexergamers in sociodemographic characteristics or PA, but male exergamers were more likely to prefer exergames to sports (29% vs 9%; $P < .0001$) and were more likely to believe exergaming was a good way to integrate PA into their lives (62% vs 32%; $P < .0001$) compared with male nonexergamers. Relative to female nonexergamers, female exergamers were more likely to be overweight or obese (40% vs 23%; $P = .006$) and employed (90% vs 78%; $P = .01$). Female exergamers were also more likely to prefer exergames to indoor and outdoor sports (46% vs 19%; $P < .0001$) and to believe exergaming was a good way to integrate PA into their lives (89% vs 43%; $P < .0001$).

Among exergamers, there was no significant difference in exergaming minutes in the previous week between men and women (88 vs 66 min, respectively; $P = .26$) (Table 2). Male and female exergamers differed significantly in their level of perceived intensity in exergames. The majority of male exergamers reported light (51%) or moderate exergaming intensity (44%), whereas female exergamers reported moderate (53%) intensity, as well as light (28%) and intense (19%) levels of exertion ($P = .02$). This may be due in part to the types of exergames the men and women played. Compared with male exergamers, female exergamers were more likely to have played fitness-training exergames in their home (32% vs 13%; $P = .006$) or dance exergames in their home (30% vs 7%; $P = .0005$). In contrast, female and male exergamers did not significantly differ from one another in their use of exergames at a friend’s house, or in their use of martial-arts or boxing exergames or sports-simulation exergames at home. Sex differences in exergaming attitudes were also found: female exergamers were more likely to believe that exergames were a good way to integrate PA into their lives (89% vs 62%; $P = .0001$) and were more likely to prefer exergames to indoor/outdoor sports (46% vs 29%; $P = .03$).

After we adjusted for covariates, male exergamers were not significantly different from male nonexergamers in moderate, vigorous, or MVPA minutes in the previous week (Table 3). Female exergamers reported 47 more minutes of moderate PA in the previous week compared with female nonexergamers ($P = .03$) and 17 more minutes of vigorous PA ($P = .42$), resulting in a total of 64 more minutes of MVPA in the previous week ($P = .06$). Male exergamers were not more likely to meet PA recommendations than nonexergaming men (odds ratio [OR], 1.35; 95% CI, 0.7–2.4, $P = .31$), and neither were exergaming women (OR, 1.29; 95% CI, 0.8–2.1; $P = .32$).

Table 1 Selected Characteristics of Study Participants, NDIT Study, 2010 (N = 829)

Characteristic	Men			Women		
	Nonexergamer (n = 306) ^a	Exergamer (n = 68)	P-value	Nonexergamer (n = 375)	Exergamer (n = 80)	P-value
Age, mean yr (SD)	24.0 (0.7)	24.2 (0.6)	.10	24.0 (0.7)	24.0 (0.7)	.86
Body mass index, mean (SD)	25.2 (4.5)	25.2 (3.6)	.98	23.0 (4.1)	25.4 (5.4)	.004
Overweight/obese, % ^b	39	41	.66	23	40	.006
Screen time ≥ 2 hr/day, % ^c	75	84	.11	65	71	.29
Currently employed, %	77	85	.15	78	90	.01
Education ≥ high school, %	95	90	.09	95	94	.56
Low income < \$20,000/yr, % ^d	15	13	.52	21	14	.07
Physical activity, min/week, mean (SD)						
Moderate	164 (276)	168 (218)	.89	82 (162)	132 (221)	.06
Vigorous	224 (292)	197 (248)	.49	107 (160)	127 (206)	.42
MVPA	388 (507)	365 (396)	.69	189 (256)	259 (374)	.11
Meets guidelines, %	60	68	.25	43	50	0.27
Prefers exergames to sports	9	29	<.0001	19	46	<.0001
Believes exergaming is a good way to integrate physical activity into life	32	62	<.0001	43	89	<.0001

Abbreviations: MVPA, moderate-to-vigorous physical activity; SD, standard deviation; NDIT, Nicotine Dependence in Teens.

^a Analysis included the full sample unless otherwise noted.

^b Missing weight data: 26 men and 47 women.

^c Missing screen data: 29 men and 49 women.

^d Missing income data: 36 men and 63 women.

Table 2 Comparison of Selected Characteristics Between Male and Female Participants Who Exergame, NDIT Study, 2010 (n = 148)

Characteristic	Men (n = 68) ^a	Women (n = 80)	P-value
Exergaming minutes, previous week, mean (SD)	88.4 (144.3)	65.7 (90.7)	.26
Level of effort when exergaming, % ^b			
Light	51	28	.02
Moderate	44	53	
Intense	4	19	
Prefers exergames to indoor/outdoor sports, %	29	46	.03
Believes exergaming is a good way to integrate physical activity into life, %	62	89	.0001
Uses exergames at home			
Plays fitness-training exergames, %	13	32	.006
Plays dance exergames, %	7	30	.0005
Plays martial-arts or boxing exergames, %	13	11	.71
Plays sports-simulation exergames, %	31	41	.19
Uses exergames at a friend's home			
Plays fitness-training exergames, %	7	9	.76
Plays dance exergames, %	16	12	.52
Plays martial-arts or boxing exergames, %	13	11	.71
Plays sports-simulation exergames, %	23	21	.74

Abbreviations: NDIT, Nicotine Dependence in Teens.

^a Analysis includes full sample unless otherwise noted.

^b Missing data: 23 men and 23 women.

Table 3 Beta Coefficients and Standard Errors From Multivariable Regression Analyses for the Association Between Exergaming and Minutes of Moderate Physical Activity, Vigorous Physical Activity, and Moderate-to-Vigorous Physical Activity in Men and Women, NDIT Study, 2010 (N = 829)

Exergamer	Minutes of moderate physical activity		Minutes of vigorous physical activity		Minutes of moderate to vigorous physical activity	
	β (SE)	P-value	β (SE)	P-value	β (SE)	P-value
Male (n = 374) ^a	-2.5 (35.8)	.94	-35.8 (38.0)	.35	-38.4 (65.1)	.55
Female (n = 455) ^a	46.9 (21.9)	.03	17.3 (21.3)	.42	64.2 (35.3)	.06

Abbreviations: NDIT, Nicotine Dependence in Teens; SE, standard error.

^a Adjusted for age, low income, employment status, education, overweight/obesity, screen time. The interpretation of the β is in comparison with nonexergamers. For example, a β of 46.9 indicates that female exergamers reported 46.9 more minutes of moderate physical activity than female nonexergamers in the previous week.

Discussion

In this observational study of young adults, exergaming contributed to moderate intensity PA minutes among women but not among men. Female exergamers spent approximately 45 more minutes per week being physically active at a moderate intensity than female nonexergamers. The results suggest the use of exergaming for PA among women is a conscious decision: compared with nonexergaming women, female exergamers believed exergaming was a good way to integrate PA into their lives and preferred exergaming to sports.

Among men, exergaming was not associated with minutes of PA. This is consistent with the literature, which suggests men might not perceive exergames as analogous to other sources of PA.²⁶ Less than 5% of exergaming men reported an intense exertion level from exergaming; the majority of men reported only light exertion. Perhaps the exergames that are currently available are not vigorous enough to challenge men to reach intense exertion levels, and the ceiling effect dissuades men from using existing exergames for exercise. However, compared with nonexergaming men, male exergamers believed exergaming was a good way to integrate PA into their lives and preferred exergaming to sports. Thus the potential for exergames to significantly contribute to PA among men still exists and should be further assessed as exergames continue to evolve and improve.

Kari et al¹⁶ found that female exergamers were more likely to report using exergames for exercise compared with male exergamers, which is consistent with our results. Compared with male exergamers, female exergamers were more likely to believe that exergames were a good way to integrate PA into their lives and were more likely to prefer exergames to indoor/outdoor sports. Intensity of exergaming was notably higher among female exergamers than male exergamers, which is consistent with the literature.^{16,19} In addition, compared with male exergamers, female exergamers were more likely to use fitness-training or dance exergames in their home, but not at a friend's home. While these results may suggest a conscious decision to exercise in the privacy of their own homes, the results should be further assessed. Nevertheless, exergaming did not contribute to minutes of vigorous PA among women, and did not significantly contribute to the likelihood that women would meeting ACSM's PA guidelines, indicating that exergaming exertion levels may also be limited among women and should be further assessed.

Limitations of this study include use of self-reports, which may overestimate PA minutes.²⁷ However, any misclassification is likely to be nondifferential. The IPAQ considers walking to be light PA, and walking may be misclassified if it was done at a moderate intensity.

Because we did not include exergaming minutes in the calculation of PA minutes, the estimation of weekly minutes of PA may not be accurate. In particular, we are unable to assess the proportion of minutes of PA that are due to exergaming. Overlap in the classification of exergaming genres is also possible. Although any overlap that results in misclassification would not affect the main results, it might affect comparison of exergaming genres between male and female exergamers. Additional research on potential sex differences in the use of exergaming and PA and meeting PA guidelines is needed. Our study sample was relatively small, and our analyses may have been underpowered and should be assessed in larger population-based samples. Nevertheless, results from our study extend the literature to further elucidate the differences in exergaming attitudes between men and women as well as between exergamers and nonexergamers. Although participants in this study were from a longitudinal cohort, exergaming data were available for only one study cycle and therefore this analysis was cross-sectional. Thus causal inference is limited and we cannot assess the contribution of exergaming to PA in the long-term. However, data on exergaming and PA in free-living adults are limited, and this is one of only a few studies that have assessed the association in a large, observational, convenience sample of young adults. Although experimental studies indicate that exergames are viable PA alternatives among sedentary adults, this study did not assess whether participants substituted exergames for other forms of PA or whether exergames contributed minutes of PA in otherwise sedentary persons.

Conclusion

In conclusion, our results indicate that exergaming contributes approximately 45 minutes of moderate-intensity PA in women per week. Exergaming may therefore be an important source of PA for women. However, exergaming was not associated with PA among men. Although exergaming may already help women increase their minutes of PA, the current landscape of exergames may be inadequate to substantially increase minutes of PA among men.

Acknowledgments

The authors thank the NDIT study participants. Kakinami is supported by a postdoctoral fellowship from the Fonds de Recherche du Québec-Santé. Sabiston is a Fonds de Recherche du Québec-Santé new investigator. Jennifer O'Loughlin holds a Canada Research Chair in the Early Determinants of Adult Chronic Disease. Sabiston holds a Canada Research Chair in Physical Activity and Mental Health. Erin O'Loughlin holds a training

grant from the Population Intervention for Chronic Disease Prevention: A Pan-Canadian Program (PICDP), Fonds de recherche du Québec - Santé (FRQS) and Fondation CHU Sainte-Justine.

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