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Energy Expenditure During Xbox Kinect Play in Early Adolescents: The Relationship with Player Mode and Game Enjoyment

Katrien Verhoeven, PhD,[1] Vero Vanden Abeele, PhD,[2] Brent Gers,[3] and Jan Seghers, PhD[4]

Abstract

Objective: There has been growing interest in the use of active videogames to influence levels of physical activity. Most studies have investigated energy expenditure in general, without taking into account moderating factors such as player mode and game enjoyment. This study therefore examines whether children's energy expenditure and game enjoyment are higher when games are played in a two-player mode than in a single-player mode.

Materials and Methods: Forty-three children from the 7th grade who exhibited an inactive lifestyle engaged in six sports exergames on an Xbox® Kinect® (Microsoft, Redmond, WA) console. The player mode (single-player or two-player mode) was manipulated (within-subjects design). The primary parameters were ''energy expenditure,'' which was measured with a SenseWear® device (Bodymedia Inc., Pittsburgh, PA), and ''game enjoyment,'' which was assessed through self-report.

Results: On average, Kinect play elicits moderate physical activity (approximately 4 metabolic equivalents of task). Games that are played in a two-player mode elicit more energy than games that are played in a single-player mode. However, this was only the case for simultaneous play (boxing, dancing, and tennis), not for turn-based play (bowling, baseball, and golf). Furthermore, participants generally liked exergaming, regardless of their sex or the player mode. Finally, no significant correlation was found between energy expenditure and game enjoyment.

Conclusions: This study has shown that Kinect play elicits physical activity of moderate intensity. Furthermore, Kinect play is generally enjoyed by both boys and girls. Simultaneous play may be the best suited to increase levels of physical activity in early adolescents who exhibit an inactive lifestyle.

Introduction

Many children fail to comply with the World Health Organization's health recommendations of at least 1 hour of moderate to vigorous physical activity a day, during most days of the week.[1,2] Inactive behavior in general, and passive videogame play in particular, has also increased during the past decade.[3] These inactive behaviors can lead to health problems such as obesity, diabetes, and heart problems.[4] Early adolescence in particular may require more focus, as longitudinal studies have shown a decrease in physical activity and an increase in inactive behavior in this age category. These behaviors are likely to be continued into adulthood, warranting prevention.[5,6] Because early adolescents enjoy playing passive videogames,[3] it is likely that active videogames possess the ability to stimulate physical activity in early adolescents who exhibit an inactive lifestyle.

There has been growing interest in the use of active videogames or exergames (i.e., electronic games that allow players to physically interact with images onscreen[7]) to influence levels of physical activity, but their efficacy needs further research. Past research has mainly focused on the energy expenditure during exergaming, particularly during Nintendo® (Kyoto, Japan) Wii® play. According to these studies, exergaming induces light- to moderate-intensity activity (approximately 3 metabolic equivalents of task

Departments of [1]Health and Well-being and [3]Teacher Education, UC Leuven-Limburg, Leuven, Belgium.
[2]e-Media Lab, Faculty of Engineering Technology, KU Leuven, Leuven, Belgium.
[4]Department of Kinesiology, KU Leuven, Leuven, Belgium.

[MET]).[8–11] This means that exergaming consumes more energy than resting, watching TV, or playing sedentary videogames but less than playing real-life sports.[12–16]

Studies investigating energy expenditure during Xbox® Kinect® (Microsoft, Redmond, WA) play are limited,[17] especially in children.[18,19] In contrast to Wii play, which sometimes allows energy-saving strategies (i.e., minor arm movements with the remote control),[11] Kinect play involves no remote control, thus stimulating full-body movement. Kinect play may therefore be more energy consuming than Wii play.[8,13,20] Furthermore, most energy studies have treated energy expenditure as a general concept, without taking into account moderating factors of energy expenditure. Insight into these factors might maximize the potential of exergames and facilitate their long-term adoption. The current study contributes to the existing research literature by looking at processes potentially underlying energy expenditure during Kinect exergaming and as such examines the relationship among energy expenditure, game experience, and player mode.

Only restricted numbers of studies have looked at the moderating relationship between energy expenditure and player mode. For instance, a pilot study in adults showed more energy expenditure in a multiplayer mode than in a single-player mode for ''Wii Boxing.''[21] Another study in adolescents showed that playing ''Wii Tennis'' against a live peer expended more energy than playing in a single-player mode.[22] The difference in energy expenditure between player modes might be explained by the competitive element, which is also embedded in traditional sport experiences.[23] Exergames that feature a competitive element are therefore more likely to induce higher levels of physical activity if played in a social, rather than in a solitary, setting.

The player mode may also moderate the enjoyment of the game. Several researchers have studied game enjoyment during sedentary videogaming. These studies have shown that playing videogames with another person intensified gameplay and is enjoyed more than playing against a computer. Playing videogames together in the same room is also more enjoyed than playing against the same person over a distance.[24–28] Fewer researchers have studied game enjoyment during exergaming.[29] Behavioral choice paradigms have shown that most children like exergaming and sometimes even prefer those games over sedentary videogaming.[30–32] Results from focus interviews have shown that children generally enjoy exergaming and prefer playing together.[33,34] To the best of our knowledge, no exergame studies have manipulated the player mode and have looked at the effect on exergame enjoyment.

Finally, energy expenditure may also be correlated with the enjoyment of the game. Several researchers have suggested that videogames that require more movement would be enjoyed more.[35–37] Playing a videogame with an accessory (i.e., replica drum, guitar) has, for instance, been shown to increase body movement and game enjoyment compared with videogames that feature a standard remote control. Based on these findings it is reasonable to assume that games that require more movement would be enjoyed more. However, theories of intrinsic motivation[38,39] may also lead one to expect a reversed relation. More game enjoyment may indicate a greater intrinsic motivation to play the game, which in turn may lead to longer and more committed gameplay and hence higher energy expenditure.

To summarize, this study examines energy expenditure during Kinect play and investigates its relationship with player mode and game enjoyment (Fig. 1). We expected a higher energy expenditure and game enjoyment when playing games in a two-player than in a single-player mode (Hypothesis 1 and Hypothesis 2, respectively) and a positive correlation between energy expenditure and game enjoyment (Hypothesis 3).

Materials and Methods

Participants

The participants of this study were recruited from a large questionnaire study in which we examined physical activity in 749 schoolchildren from the 7th grade (nine schools in Leuven, Belgium, with a response rate of 44 percent).[40] Children were included in the current study if they had an inactive lifestyle as measured with the World Health Organization's Health Behavior in Schoolchildren Questionnaire (HBSC).[41] We defined an inactive lifestyle as ''less than 60 minutes of moderate physical activity a day for a maximum of 4 days a week, combined with more than 2 hours of screentime a day'' (HBSC items 1 and 5–7). Children were excluded if they (1) had physical problems that could hamper the exergame behavior and experience, (2) were not fluent in Dutch, and (3) lacked the parental consent to participate in the experiment. Eighty of the 187 eligible children were contacted in order to complete the research schedule ($n=48$) (64 percent agreed to participate, 25 percent declined because of lack of interest or time, and 11 percent were unreachable by telephone). Because of illness five participants dropped out, which brought the actual research sample down to 43 children (21 boys, 22 girls; median age, 13.0 years; standard deviation [SD] = 0.88 years; minimum, 12 years; maximum, 16 years).

Measurements and equipment

Sample characteristics. Sociodemographic characteristics (i.e., sex, age, game experience) were obtained with a self-constructed questionnaire. Standing height and body weight were measured using Seca scales (models 214 and 881; Seca, Hamburg, Germany).

Exergames. We selected six sport exergames. Five games were derived from ''Kinect Sports'' and ''Kinect Sports: Season 2'' (Microsoft): boxing, bowling, tennis, baseball, and golf. These games were chosen because they are comparable with ''Wii Sport'' games that have already been studied in previous research.[13,14,42] We also included

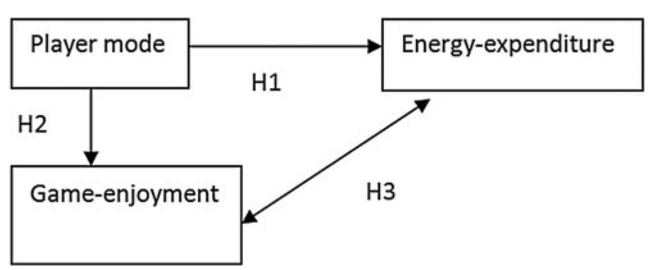

FIG. 1. Test model. H, hypothesis.

"Just Dance 3" (Ubisoft, Montreuil, France) because girls may prefer dancing over other sport games.[42] All games were played on the same level of difficulty ("beginner").

Energy expenditure. Energy expenditure was estimated with the SenseWear® Pro 3 armband (Bodymedia Inc., Pittsburgh, PA). The SenseWear is a valid and practical tool to assess energy expenditure in children.[43,44] This device is a multisensor body monitor, worn over the triceps muscle of the right arm. It enables continuous collection of various physiological and movement parameters through multiple sensors, including a two-axis accelerometer and sensors measuring heat flux, galvanic skin response, skin temperature, and near-body ambient temperature. Data from all these sensors are combined with gender, age, body weight, and height to estimate energy expenditure, physical activity intensity, and number of steps, using algorithms developed by the manufacturer. In line with other research, we used MET as the primary outcome measurement of energy expenditure during exergaming. The MET values estimated the average energy expenditure during the 10-minute playing interval.

Game enjoyment. Game enjoyment was measured with the Kids Game Experience Questionnaire (kidsGEQ).[45] This questionnaire is based on the adult Game Experience Questionnaire.[46] The kidsGEQ measures game experience with 21 items divided into seven subscales (Positive Affect, Negative Affect, Flow, Immersion, Tension, Challenge, and Competence). For the current study we have presented this scale to experts in the field of game research who selected five items from this questionnaire that they believe are able to measure game enjoyment adequately (item 3, "I enjoyed playing"; item 6, "I found it boring"; item 11, "I felt great during game play"; item 14, "the game was dull"; and item 21, "playing was annoying"). Each item was scored on a 5-point scale ranging from 0 ("not at all") to 4 ("very much"). Negative items were rescaled. Average scores were calculated by adding up the scores for the five items and dividing them by the number of valid items. If more than 25 percent of the items was missing, the total scores were considered missing. Higher scores indicated a higher game enjoyment. Cronbach's alpha scores are presented in Table 2.

Player mode. Participants played six exergames in a single-player and two-player mode (we also refer to this as "single-play" versus "duo-play"). All duo-play games were played in a competitive mode. Participants were grouped into boy–boy and girl–girl dyads. Due to dropout, four dyads were mixed boy–girl. Participants were not able to choose their opponent. Most participants did not know their opponent (90.7 percent) but generally liked them (mean = 7.63; SD = 2.00; range 0 ["I did not like my opponent"] to 10 ["I liked my opponent a lot"]).

Procedures

Prior to the current study, the participants engaged in a survey study about physical activity, which took place at their school. Based on their HBSC physical (in)activity scores, the participants were divided into five groups, which were, respectively, active on 0, 1, 2, 3, or 4 days of the week combined with more than 2 hours of screentime a day. Group 1 was the most inactive group, and Group 5 was the least inactive group. In order to make sure our research sample contained the least active children, we first contacted all the children of Group 1, then Group 2, and so on, until the research schedule was completed. Twelve children a day participated on one of our four research days.

When the participants and their parents arrived at the research venue (gym), they received information about the proceedings of the day and provided informed consent. Their measurements were taken, and they received a SenseWear and completed questionnaires. After this introduction, the participants went to the research area, where six Kinect consoles were displayed. Each console displayed one of the six exergames and was supervised by another research assistant.

Before the start of the experiment children were familiarized with the exergames in small groups. Research assistants demonstrated the games, and children practiced each exergame for a few minutes. After this familiarization (±1 hour), participants played all six exergames, in both single-player and two-player mode (within-subjects design), 12 play sessions in total. In order to avoid order effects, the participants alternated between the six consoles on a rotation basis (the game order was varied). Games were played for 10 minutes each. After each game there was a 10-minute break, during which the game-enjoyment questionnaire was completed. Exergames were presented in four game blocks, each consisting of three exergames. Each block took approximately 1 hour to complete. Between blocks there was a 15-minute break. Two blocks were played in the morning and two in the afternoon. The order of the single-play and duo-play was counterbalanced: the participants of Day 1 started with duo-play in the morning (blocks 1 and 2) and ended with single-play in the afternoon (blocks 3 and 4), whereas participants of Day 2 started with single-play in the morning (blocks 1 and 2) and ended with duo-play in the afternoon (blocks 3 and 4).

The study protocol was approved by the Board of Applied Scientific Research (PWO).

Data analysis

The data were analyzed with SPSS version 22 software (SPSS, Inc., Chicago, IL). We investigated differences in energy expenditure and game enjoyment between single-play and duo-play by means of repeated-measures analyses of variance. First, we looked at the energy expenditure/game enjoyment, without taking into account game differences. Therefore we calculated an average energy expenditure/game enjoyment score ("all games average"), for both single-play and duo-play. If 25 percent of the data or more were missing, the average score was considered missing. The average score was entered as a dependent variable in the repeated-measures analyses. Second, we looked at the energy expenditure/game enjoyment of the six exergames separately by using six repeated-measures analyses, with the energy expenditure/game enjoyment score for single-play and duo-play for each exergame as a dependent variable. Because some studies have found sex differences in energy expenditure and game enjoyment,[18] the child's sex was entered as a between-subjects variable in all repeated-measures analyses. If interaction effects were found, results were further analyzed using independent-sample t tests.

Table 1. Means and Standard Deviations of Energy Expenditure During 10 Minutes of Single-Play and Duo-Play and Repeated-Measures Analyses with Energy Expenditure as the Dependent Variable and Player Mode and Sex as Between-Subject Variables

	Mean (SD)		*Repeated-measures analyses*	
	Single-play	*Duo-play*	*Effect*[a]	F
Dancing ($n=36$)	5.31 (1.15)	5.77 (1.11)	P	28.20[c]
			P×S	4.50[b]
Boxing ($n=35$)	6.27 (1.37)	7.04 (1.59)	P	4.51[b]
			P×S	0.55
Bowling ($n=34$)	3.80 (0.77)	3.21 (0.50)	P	21.07[c]
			P×S	1.02
Tennis ($n=33$)	3.90 (0.90)	4.66 (1.19)	P	19.07[c]
			P×S	0.34
Golf ($n=37$)	2.87 (0.92)	2.95 (0.78)	P	0.53
			P×S	3.14
Baseball ($n=36$)	4.00 (1.04)	4.11 (0.78)	P	0.00
			P×S	0.78
Average all games ($n=32$)	4.31 (0.61)	4.58 (0.71)	P	5.43[b]
			P×S	0.58

Energy expenditure is given in metabolic equivalents of task (MET).
[a]P, player mode; S, sex.
[b]$P<0.05$, [c]$P<0.001$.
SD, standard deviation.

Finally, we investigated the relationship between energy expenditure and game enjoyment by means of Pearson correlation analyses.

Results

Participants' characteristics

The body mass index of the majority of the children was normal (mean = 19.09 kg/m^2; SD = 2.85 kg/m^2; range, 14–29 kg/m^2; 9.3 percent were underweight, and 14 percent were overweight).[47] All participants had played videogames before: 30.2 percent sometimes, 34.9 percent regularly, and 34.9 percent often. Most children had never played the Kinect before (90.7 percent). The group distribution of participants' inactivity was 11.9 percent, 21.4 percent, 33.3 percent, 26.2 percent, and 7.1 percent, respectively for Group 1–5.

Relationship between energy expenditure and player mode

Without taking into account game differences, children consumed more energy in a two-player mode (mean = 4.58; SD = 0.71) than in single-player mode (mean = 4.31; SD = 0.61) ($F_{1,30}=5.43$, $P<0.05$) (Table 1). No sex differences were found ($F_{1,30}=0.58$; $P>0.05$).

When we look at the separate games, children consumed significantly more energy in a two-player mode than in a single-player mode when playing boxing, tennis, and dancing, whereas children consumed significantly less energy in a two-player mode than in a single-player mode when playing bowling. For golf and baseball no significant differences were found. For dancing, girls expended more energy during single-play than boys ($t_{35}=-2.05$, $P<0.05$) but not during duo-play ($t_{37}=-0.76$, $P>0.05$).

Relationship between game enjoyment and player mode

Without taking into account game differences, no differences in game enjoyment occurred between duo-play (mean = 3.46; SD = 0.34) and single-play (mean = 3.52; SD = 0.27) ($F_{1,34}=0.03$, $P>0.05$) (Table 2). There was also no difference in game enjoyment between boys and girls ($F_{1,34}=0.13$, $P>0.05$).

When we look at the separate exergames, no difference in game enjoyment between single-play and duo-play occurred, except for baseball.

Table 2. Means, Standard Deviations, and Scale Reliability (Cronbach's Alpha) of Exergame Enjoyment During Single-Play and Duo-Play and Repeated-Measures Analyses with Exergame Enjoyment as the Dependent Variable and Player Mode and Sex as Between-Subject Variables

	Cronbach's alpha		*Mean (SD)*		*Repeated-measures analyses*	
Exergame	*Single-play*	*Duo-play*	*Single-play*	*Duo-play*	*Effect*[a]	F
Dancing ($n=39$)	0.93	0.86	3.20 (0.80)	3.20 (0.75)	P	1.62
					P×S	3.00
Boxing ($n=37$)	0.56	0.75	3.70 (0.22)	3.60 (0.42)	P	1.26
					P×S	2.21
Bowling ($n=38$)	0.83	0.70	3.62 (0.41)	3.52 (0.41)	P	1.94
					P×S	1.27
Tennis ($n=35$)	0.87	0.81	3.62 (0.33)	3.72 (0.22)	P	2.53
					P×S	1.61
Golf ($n=41$)	0.86	0.80	3.07 (0.79)	3.17 (0.70)	P	1.21
					P×S	0.54
Baseball ($n=37$)	0.83	0.87	3.64 (0.30)	3.48 (0.44)	P	6.54[b]
					P×S	0.95
Average all games ($n=36$)			3.52 (0.27)	3.46 (0.34)	P	0.03
					P×S	0.13

[a]P, player mode; S, sex.
[b]$P<0.05$; range 0–4.
SD, standard deviation.

Relationship between energy expenditure and game enjoyment

Without taking into account game differences, no significant correlation was found between energy expenditure and game enjoyment for single-play ($r=0.19$, $P>0.05$) and duo-play ($r=-0.03$, $P>0.05$) (Table 3).

Furthermore, when looking at the separate exergames, no correlation could be established between energy expenditure and game enjoyment for most exergames.

Discussion

The current study investigated the energy expenditure of six Kinect games and its relationship with player mode and game enjoyment.

In line with our first hypothesis, exergaming generally uses more energy in a two-player mode than in single-player mode. However, important differences can be distinguished between games. Although children indeed consumed more energy in a two-player mode than in single-player mode when playing boxing, tennis, and dancing, this was not the case for baseball, golf, and bowling. These differences can be explained by looking at how duo-play is embedded in the game, in particular, whether players are playing simultaneously or take turns. In this regard, Mueller et al.[48] have proposed a taxonomy of exertion games that can be useful. We used this taxonomy to explain our results and have extended it (in Fig. 2 the original taxonomy is shown above the dashed line).

Some of our duo-play exergames offered ''nonparallel'' play (tennis, boxing, dancing), whereas others offered ''parallel'' play (golf, baseball, bowling). Nonparallel play is defined as gameplay where one player creates or functions as a direct obstacle to the other player, who needs to overcome this obstacle. Consequently, players play simultaneously during nonparallel play. Typically these games involve the concept of offense and defense during gameplay.[49] Real-life examples are, for instance, soccer and boxing. In contrast, parallel play is defined as gameplay where player activities are performed independently of those of the other player. One player has no direct influence on the difficulty of the task faced by the opponent. Real-life examples are, for instance, swimming and bowling. In these sports, players often use their own lane or field (''synchronous play'' [athletics, swimming]) or take turns (''turn taking play'' [bowling, pole vault]). In the latter, while one player takes a rest, the other player is performing the activity. Obviously, turn-based parallel play halves the energy expenditure during gameplay compared with nonparallel play. Hence, turn-based parallel play might not be ideal when aiming for a high MET consumption. Based on this finding, and supported by our results, nonparallel duo-play (tennis, boxing) or synchronous parallel play (dancing) consumes the most energy and may have the most potential in stimulating physical activity in children, as illustrated by the extended taxonomy in Figure 2 (below the dashed line).

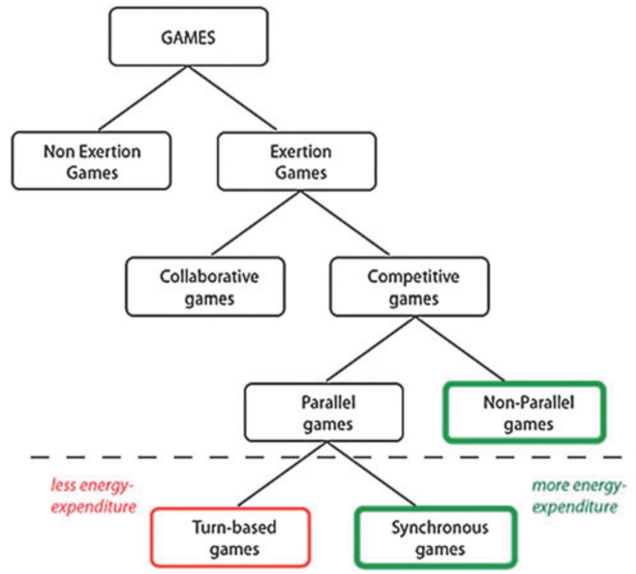

FIG. 2. Exergame taxonomy, based on that of Mueller et al.[48] but extended to include turn-based versus synchronous play and the relation with energy expenditure. (Color graphics available at www.liebertonline.com/g4h)

TABLE 3. CORRELATIONS (R) BETWEEN ENERGY EXPENDITURE AND GAME ENJOYMENT FOR SINGLE-PLAY AND DUO-PLAY

Exergame, player mode	*Game enjoyment versus energy expenditure* r
Dancing	
Single	0.37[a]
Duo	0.22
Boxing	
Single	0.07
Duo	−0.02
Bowling	
Single	0.08
Duo	−0.04
Tennis	
Single	0.07
Duo	−0.21
Golf	
Single	0.17
Duo	0.02
Baseball	
Single	0.07
Duo	−0.44[b]
Average all games	
Single	0.19
Duo	−0.03

[a]$P<0.05$, [b]$P<0.01$

Furthermore, our research has shown that Kinect play, which on average exceeds 4 MET, can be considered as a moderately intense physical activity. As a consequence, Kinect play can therefore contribute to children's health in the same way as other moderately intense physical activities (i.e., climbing stairs, walking, etc.). These results concur with the results of Rosenberg et al.,[18] who found an overall MET consumption of 3 MET while playing Kinect sports. However, in their study no MET values were calculated for the different sport games. In our study we found game differences in energy expenditure. Children consumed most energy when playing boxing (6.6 MET) and dancing (5.7

MET) and least energy while playing bowling (3.5 MET) and golf (2.9 MET); the energy consumed playing tennis (4.2 MET) and baseball (4.0 MET) was intermediate. This ranking concurs with studies of ''Wii Sport'' games (see reviewed by Biddiss and Irwin[8]: ''Wii Boxing,'' 3.2–4.2 MET; ''Wii Bowling,'' 2.2 MET; and ''Wii Tennis,'' 2.4 MET). The MET values in the current study, however, are higher, and this seems to support the assumption that Kinect play without a remote control uses more energy than Wii play with a remote control. If we focus on the nonparallel duo-play or synchronous parallel play (dancing, boxing, tennis), we find an average of 5.3 MET, whereas for turn-based parallel play (golf, baseball, bowling), we find an average of 3.4 MET, a difference of 2 MET. Hence, rather than prescribing a two-player mode instead of a single-player mode, we recommend avoiding turn-based parallel play.

To our surprise, we found no support for our second and third hypotheses. No differences in game enjoyment were found between single-play and duo-play, which contradicts other studies that favored social play in terms of enjoyment.[24,26] Also, no relationship occurred between energy expenditure and game enjoyment. Several explanations can account for these findings. Game enjoyment scores were very high in this study. Ceiling effects may have masked differences between single-play and duo-play. It is also possible that the 10-minute playing interval was too short to detect differences in enjoyment between duo-play and single-play. It may also be the case that the novelty of the games played a role. Despite the lacking support for our second and third hypotheses, we did show that children really liked exergaming, regardless of the player mode and their sex. These results concur with the qualitative results of focus interviews about children's exergaming attitudes.[33,34]

Limitations

We used the kidsGEQ[45] to measure game enjoyment. The authors themselves[45] have postulated that ''game experience'' should not be treated as a unidimensional construct. We intended to use the Positive and Negative affect subscales for this study as a measurement of ''game enjoyment,'' but the internal consistency of these scales was too low. In order to increase scale reliability, we asked experts in the field of game research to identify items that measured game enjoyment and then used these items instead of the subscales. Difficulties measuring game enjoyment showed important implications for further research. Existing scales for measuring game enjoyment clearly need further reliability testing. Furthermore, using a game enjoyment questionnaire may not be ideal to measure exergaming enjoyment. Although passive videogaming and exergaming share similar features, exergaming is still different from passive videogaming. Therefore we make a plea for measurement development in this research area.

Furthermore, the results of this study are limited to children from the 7th grade, who exhibit an inactive lifestyle, and should not be generalized without further research.

Research recommendations

This study was the first study to investigate the role of duo-play in children's energy expenditure and game enjoyment during Kinect play. Although this study has obtained interesting results regarding duo-play, it is clear that duo-play is complex and may in itself be influenced by several factors. Future research should further disentangle the components of duo-play that may influence energy expenditure and game enjoyment. For instance, researchers could manipulate dyad formation (i.e., same sex versus mixed sex) and investigate the effects of this manipulation on game enjoyment and energy expenditure or could also investigate the relationship between game enjoyment and the affinity with the opponent (i.e., stranger versus friend).

Furthermore, most energy studies have examined ''exergaming'' as one monolithic game genre. However, this study suggests that differences in game type and game characteristics (i.e., turn-based parallel play versus synchronous nonparallel play) also influence the energy expenditure during exergaming. This raises a general concern. Interventions studies should not treat exergames as one monolithic game genre with equal outcomes on energy expenditure, but should differentiate between games. The extended taxonomy (Fig. 2) is in that respect a first attempt to further detail the type of duo-play taking place within the exergame, as well as its impact on energy expenditure.

Furthermore, other elements of the game shell (i.e., choosing avatars, levels, and other player attributes, replays of gameplay, leaderboards, victory animations, cut-scenes that illustrate the sports, etc.) can equally reduce actual playtime and can therefore influence overall measured energy expenditure. Moreover, any game researcher will point out that specific in-game mechanics such as time pressure, elements of chance, narratives, puzzles, etc., equally generate different esthetic game experiences and might impact the motivation to play longer and/or more intensively, hence influencing energy expenditure.[50] Therefore, we call for future studies to analyze and report in greater detail the impact of in-game elements on energy expenditure.

Conclusions

This study investigated the role of duo-play in children's energy expenditure and game enjoyment. It has shown that Kinect play elicits activities of moderate intensity that are generally enjoyed by both boys and girls. Although duo-play elicits more energy than single-play, this finding should be nuanced. Only nonparallel duo-play elicits more energy expenditure, as opposed to turn-based parallel play. Simultaneous duo-play may therefore be best suited to increase levels of physical activity in inactive early adolescents.

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Author Disclosure Statement

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Address correspondence to:
Katrien Verhoeven, PhD
Department of Health and Well-being
UC Leuven-Limburg
Herestraat 49
3000 Leuven, Belgium

E-mail: katrien.verhoeven@ucll.be