# Play Pattern of Seated Video Game and Active "Exergame" Alternatives

Jessica W.K. Lam, Cindy H.P. Sit, Alison M. McManus

*Institute of Human Performance, University of Hong Kong, Pokfulam, Hong Kong, CHINA*

The purpose of the study was to compare the play pattern of "exergames" and seated internet-based video games between boys and girls. Seventy-nine participants (40 boys, 39 girls) aged 9 to 12 years ($M = 10.85 \pm 0.9$) were involved in two 1-hour video game sessions. Play pattern in terms of frequency, duration and intensity were assessed from observation, accelerometry and heart rate monitoring. Results indicated that children spent half of the available time playing the activity-promoting exergames (XaviX bowling 47.6 ± 14.9%; XaviX J-Mat 48.8 ± 12.8%). No differences between the boys and girls were apparent for total time played, number of play bouts or duration per bout ($p \geq 0.05$). Boys however played both exergames more actively than the girls (XaviX bowling RT3 counts.$s^{-1}$: boys 10.47 ± 4.71, girls 6.34 ± 2.76; XaviX J-Mat RT3 counts · $s^{-1}$: boys 66.37 ± 13.84, girls 51.94 ± 17.83). This study concludes that both boys and girls choose to play exergames for similar periods of time, but play style during the XaviX bowling was often inactive in the girls and during the XaviX J-Mat less active in the girls than the boys. Reasons underlying choice of play was similar between the girls and boys. Active video games appear to be suitable for longer-term physical activity interventions in children, but attention will need to be given to the intensity of game play in girls.
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**Keywords:** choice behavior, gender, physical activity, play and play things, video games

## Introduction

A variety of new generation console video game platforms have added a physical activity component to the otherwise seated video game environment, offering an attractive alternative for increasing physical activity and combating some of the health risks from excessive sitting (Hamilton et al. 2008).

Previous studies have shown that playing activity-promoting video games, or "exergames", can increase energy expenditure considerably above seated video game play in children (Lanningham-Foster et al. 2009; Mellecker & McManus 2008; Unnithan et al. 2006). The amount of physical activity obtainable from exergame play varies with game needs (Graves et al. 2008). Games requiring only hand and minimal lower-body movements such as bowling require only low intensity activity (Graves et al. 2008; Mellecker & McManus 2008). Games requiring lower-body or whole body movements such as the XaviX J-Mat, Dance Dance Revolution or the Wii Sports boxing elicit moderate to vigorous levels of physical activity, increasing energy expenditure three- to four-fold above rest (Lanningham-Foster et al. 2009, 2006; Graves et al. 2008; Mellecker & McManus 2008; Unnithan et al. 2006). However, it should be noted that the inter-individual variation in play intensity for active video games requiring higher intensity physical activity has been found to be wide, suggesting play style varies considerably between individuals (Mellecker & McManus 2008).

Re-engineering physical activity into valued sedentary activities of children provides the possibility of activity interventions which minimize disruption to normal routines and work with, rather than against,

Corresponding Author
Cindy H.P. Sit, Institute of Human Performance,
University of Hong Kong, Pokfulam Road,
Hong Kong, CHINA.
E-mail: sithp@hku.hk

preferred leisure pursuits. However, for these to be effective activity alternatives, we need to develop an understanding of who chooses to play, how they play and why (Pate 2008). Gender has been shown to be a stronger predictor of video game use than either socioeconomic status or ethnicity. Video games require spatial cognition skills which are known to be superior in men compared to women, and it has been suggested that video games may have less appeal to girls than boys (Quaiser-Pohl et al. 2006; Terlecki & Newcombe 2005). This is supported by evidence that girls play video games less often and for shorter periods of time than boys (Graves et al. 2008; Hamilton et al. 2008); and when playing actively, they expend less energy than boys (Sit et al. 2010; Graf et al. 2009). Additionally, it has been shown that video game play results in significant neural activation of those regions of the brain associated with reward and this is greater in men than in women (Hoeft et al. 2008). Video game play may therefore simply not be as attractive for girls or may be more rewarding and reinforcing for boys.

In addition to playing video games more, boys also tend to be more physically active and engage more in higher-intensity exercise activities, whilst girls prefer lower-intensity activities (Trost et al. 2002). Whether exergames appeal more to boys than to girls and whether this appeal translates into differing play patterns, such as boys choosing active video games more than girls, playing more vigorously than girls or spending longer periods of time playing exergames compared to girls, is not currently known.

The purpose of this study was to investigate the pattern of exergame and seated internet-based video game play in boys and girls. Play pattern is defined as the frequency, duration and intensity a game is played. In addition, we investigated the reasons boys and girls chose to play or stop playing a particular game. We hypothesized that: (1) boys would choose to play exergames more frequently, for longer periods of time and more intensely than girls; and (2) the reasons given for choosing or stopping play of video games would differ by game mode (seated internet-based video games or low and moderate-to-vigorous activity-promoting exergames) and by gender.

## Methods

### *Participants*

Seventy-nine 9–12-year-old children (40 males, 39 females) were recruited from two subsidized government primary schools, randomly selected (from a computer-generated assigned number) from Government Education Bureau lists. Informed consent was given by the parents and none of the participants had any physical limitations or chronic disease. All experimental protocols were approved by the institutional review board for human research ethics.

### *Procedures*

Participants were asked to attend the university laboratory individually. Upon arrival, the children had height measured barefoot to the nearest 0.1 cm (Invicta 2007246 Stadiometer, Leicester, UK), body mass assessed to the nearest 0.1 kg barefoot in light-weight clothing using electronic scales (Tanita, Tokyo, Japan), and body mass index [BMI, $kg \cdot (m^2)^{-1}$] was computed. Children then completed a familiarization session during which they were fitted with an accelerometer and heart rate monitor, and given an opportunity to become accustomed to the format and controls for each of the video games. The children then sat quietly for 10 minutes prior to beginning the first of two 1-hour video game play sessions.

In the $1^{st}$ hour, the children were able to play either a low-intensity bowling exergame or content-matched internet-based video game. Following a 45-minute rest period, the children completed the $2^{nd}$ hour, playing either a moderate-to-vigorous running exergame or content-matched internet-based video game. At the end of each of the 1-hour sessions, the children completed a semi-structured interview. Game order (low intensity preceding higher intensity) was pre-set in an attempt to reduce energetic carryover between the two 1-hour sessions. One-hour play sessions were chosen because previous research has shown that in the home environment, children play video games for approximately 1 hour per session (Rideout et al. 2010). The 45-minute rest period was chosen to allow the children sufficient time to take a break and complete the semi-structured interview.

During each of the 1-hour sessions, each child was given equal access to the seated internet video game and exergame and could switch between the games as many times as they liked. None of the children had played any XaviX games before and none had owned or played other exergame platforms. All the children had used a computer and had played a computer or internet-based video game prior to the study; however, none had played either of the internet video games chosen for this study.

***Measures***

*Video games*

The two games offered in the 1st hour were a seated internet-based ten-pin bowling video game and the low intensity XaviX bowling exergame. The internet bowling game required the mouse to be held down for a predetermined time and then released to complete a successful bowl. Scores were accumulated and a "game" score given after 10 attempts. The XaviX bowling game was played with a wireless bowling ball and XaviX receiver connected to a LCD screen. The participants stood 3–5 feet away from the screen, stepped and swung the wireless ball toward the screen over camera sensors in the XaviX receiver. Again, scores were accumulated and a game score given after 10 attempts. Each game took approximately 3–4 minutes to complete.

In the 2nd hour, the children could play either a seated internet-based running video game or the more vigorous XaviX J-Mat exergame. The internet running game required the child to use the mouse to help a runner complete a running course whilst avoiding obstacles. At the end of each game, a thermometer indicated game score, with a higher reading indicating a better score. The game lasted as long as the participant successfully navigated the obstacles. The XaviX J-Mat game consists of a floor mat, which relays game performance via infrared to the XaviX receiver connected to a screen. The XaviX J-Mat "Jackie Chan Action Run" game was chosen, which involved completing a journey through the streets of Hong Kong by walking or running on the mat, while dodging barriers and eliminating ninjas by sidestepping, squatting and jumping. Each game lasted 5 minutes and at the end of the game, a score from A (Excellent) to D (Try again) was provided. The screen size of the computer monitor and XaviX LCD monitor were the same.

*Duration and frequency of video game use*

The same trained observer continuously observed each child's video game use, noting each time the child chose a particular game (frequency) and recording the length of time spent playing that game using a stop watch. The time spent playing each game was computed per play bout (duration per bout), and also expressed as a total by summing up the time intervals for each bout of play and expressing this as a percentage of the total time played (total duration played). Total time played averaged $58 \pm 4$ minutes in the 1st hour and $56 \pm 6$ minutes in the 2nd hour.

*Intensity and cardiovascular effort during video game play*

The intensity of play was assessed from triaxial accelerometer output (RT3 accelerometer, Stayhealthy Inc., Monrovia, CA, USA) and cardiovascular effort from heart rate telemetry (Polar S810, Polar Electro Oy, Kempele, Finland).

The RT3 accelerometer was placed in a nylon pouch, attached to a belt and worn on the right hip. Data were expressed as counts for all three axes summed per second. The RT3 output was time- and game-aligned with the observation data and runs of zeros were only accepted when they did not exceed observed periods of sitting. The intensity of each bout of play was classified using previously established criteria (Chu et al. 2007): (1) sedentary, $<2$ METs equivalent to $<7.0$ RT3 counts.sec$^{-1}$; (2) low intensity, $\geq 2$ but $<3$ METs equivalent to $\geq 7.0$ but $<31.0$ RT3 counts.sec$^{-1}$; (3) moderate intensity, $\geq 3$ but $<6$ METs equivalent to $\geq 31.0$ but $<68.5$ RT3 counts.sec$^{-1}$; and (4) vigorous, $\geq 6$ METs equivalent to $\geq 68.5$ RT3 counts.sec$^{-1}$).

Cardiovascular effort per play bout was assessed from heart rate monitoring. Heart rate data were stored every 5 seconds and were time- and game-aligned with the observation data. Zeros were replaced by imputing heart rate values using the average of the previous and next recorded heart rate values.

*Reasons underlying play choice*

Semi-structured interviews were conducted at the end of each 1-hour play session. All the interviews were conducted by the same trained facilitator and were videotaped and transcribed verbatim. Participants were asked to indicate their main reason(s) for choosing to play or end each of the games guided by the following questions:

1. *Choosing a game:* Let's talk about your main reasons for choosing to play the game. Do you remember which game you played first? What was your main reason for choosing that game? Did you play the other game? Why did you choose to play it?
2. *Ending a game:* You started playing that game—do you remember why you ended it? What was your main reason for ending the game? What about the other game—did you end it for the same reason?

Thematic content analysis was used to analyze the interview transcripts. Thematic analysis focuses on identifying themes relating to patterns of behavior and the results presented herein are analytical interpretations of the themes identified (Ziebland & McPherson 2006).

Specifically, using a qualitative approach, we found three key reasons for choosing or ending a game, which were: (1) external influences, essentially being attracted to a game or distracted by another; (2) frustration, or a lack of success in achieving satisfaction while playing; and (3) internal feelings, largely tiredness and boredom. We then used a quantitative approach to summarize the findings by creating a tally of the number of times each reason was chosen for either choosing or ending each of the four games. This quantitative count for each of the three reasons by game mode formed the variable of analyses.

### *Statistical analyses*

Participant characteristics (height, weight, BMI) were compared by gender using one-way ANOVA. The influence of gender on video game play pattern (frequency, duration and intensity of play) and the reasons given for choosing or ending a video game were established using analysis of variance with repeated measures. The within-subject factor was play mode (seated internet bowling video game, seated internet running video game, low intensity XaviX bowling exergame, moderate-to-vigorous intensity XaviX J-Mat running exergame). The between-subject factor was gender (male or female). We included the covariate BMI because boys were heavier and had a higher BMI than girls and therefore these analyses were all repeated-measures analyses of covariance (RM ANCOVA). Greenhouse-Geisser probability levels were used to adjust for sphericity where necessary. Interactions and main effects were deconstructed using analysis of simple effects where appropriate. A $p$ value of 0.05 was set *a priori*.

## Results

Descriptive characteristics are provided in Table 1. The boys and girls were similar in age and height, but based on the International Obesity Task Force definitions of child obesity (Cole et al. 2000), boys were heavier and had a greater BMI ($p \le 0.05$). BMI was used as a covariate for subsequent analyses.

### *Video game use*

A play mode by gender RM ANCOVA (with BMI as the covariate) showed no main effect of play mode on the amount of time the children used each game, with the children spending approximately half (48.9 ± 13.4%) of the available time playing the XaviX exergames (XaviX bowling: 47.6 ± 14.9%; XaviX J-Mat: 48.8 ± 12.8%). A similar amount of time (46.2 ± 14.5%) was taken to play the seated internet video games (internet bowling: 48.7 ± 24.3%; internet running: 43.8 ± 13.0%). No main effect of gender or an interaction was evident (Figure).

**Table 1.** Anthropometric values by gender*

| | Age (yr) | Height (cm) | Body mass (kg) | BMI [kg · (m²)$^{-1}$] |
|---|---|---|---|---|
| Boys ($n$ = 40) | 11.2 ± 0.8 | 145.0 ± 7.1 | 42.9 ± 11.8† | 20.2 ± 4.4† |
| Girls ($n$ = 39) | 11.4 ± 0.8 | 146.2 ± 7.7 | 37.3 ± 8.7 | 17.2 ± 2.5 |

*Data are presented as mean ± standard deviation; †significant difference between groups at $p \le 0.05$.

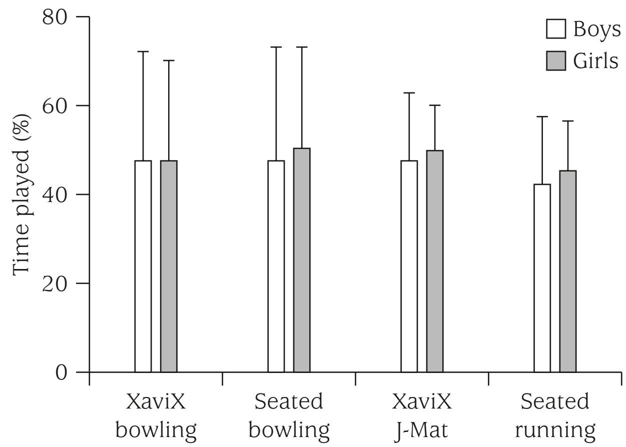


**Fig.** Percentage of time per session spent playing XaviX and internet video games by gender.

Mean values for the frequency of play bouts within an hour, the total duration of play and the duration per bout are provided by play mode and gender in Table 2. There were no main effects of play mode or gender, or interactions for frequency, duration or duration per play bout.

### *Intensity of play*

The mean RT3 counts and heart rate per play bout are provided by play mode and gender in Table 3. Of the 79 children, RT3 data were available for 73. A main effect of play mode [$F(3,195) = 22.745$, $p \le 0.001$, $\eta^2 = 0.259$], gender [$F(1,65) = 16.009$, $p \le 0.001$, $\eta^2 = 0.199$], and a play mode by gender interaction [$F(3,195) = 7.747$, $p \le 0.01$, $\eta^2 = 0.106$] were evident for RT3 counts. Follow-up analyses showed that RT3 counts during both the XaviX bowling and XaviX J-Mat games were significantly higher than either internet game and higher during the XaviX J-Mat game compared to the XaviX bowling ($p \le 0.05$). The RT3 counts during both

**Table 2.** Frequency of play bouts, duration, and duration per bout for XaviX and internet video games by gender*

| | XaviX bowling | Internet bowling | XaviX J-Mat | Internet running |
|---|---|---|---|---|
| Frequency of play bouts ($n$) | | | | |
| Boys ($n=40$) | 3 ± 3 (0–12) | 4 ± 3 (0–10) | 4 ± 2 (1–10) | 6 ± 3 (0–12) |
| Girls ($n=39$) | 3 ± 2 (0–9) | 4 ± 2 (0–8) | 4 ± 2 (1–7) | 5 ± 2 (1–10) |
| Total duration of play (min) | | | | |
| Boys ($n=40$) | 29.4 ± 14.6 (0.0–60.0) | 28.3 ± 15.5 (0.0–60.0) | 29.3 ± 8.8 (11.5–60.0) | 25.4 ± 8.6 (0.0–42.8) |
| Girls ($n=39$) | 28.3 ± 15.5 (0.0–60.0) | 29.3 ± 8.6 (0.0–60.0) | 30.0 ± 6.2 (11.6–40.6) | 27.1 ± 6.8 (13.4–43.0) |
| Duration per play bout (min) | | | | |
| Boys ($n=40$) | 10.1 ± 9.4 (0.0–60.0) | 13.1 ± 16.3 (2.5–60.0) | 8.9 ± 9.7 (2.8–60.0) | 6.0 ± 5.1 (0.0–30.5) |
| Girls ($n=39$) | 11.5 ± 9.7 (0.0–60.0) | 11.6 ± 11.3 (0.0–60.0) | 9.6 ± 6.6 (3.4–38.8) | 7.6 ± 5.0 (1.7–21.4) |

*Data are presented as mean ± standard deviation (range).

**Table 3.** Intensity and cardiovascular effort of playing XaviX and internet video games by gender*

| | XaviX bowling | Internet bowling | XaviX J-Mat | Internet running |
|---|---|---|---|---|
| Intensity per bout (RT3 counts · $s^{-1}$) | | | | |
| Boys ($n=36$) | 10.5 ± 4.7† (3.0–24.2) | 1.3 ± 1.3 (0.0–7.1) | 66.4 ± 13.8† (27.9–90.5) | 4.3 ± 5.8 (0.1–38.2) |
| Girls ($n=37$) | 6.3 ± 2.8 (2.4–24.2) | 0.9 ± 0.6 (0.2–2.3) | 51.9 ± 17.8 (17.0–92.8) | 3.3 ± 5.0 (0.2–31.3) |
| Cardiovascular effort per bout (beats · $min^{-1}$) | | | | |
| Boys ($n=40$) | 100 ± 13 (74–130) | 87 ± 12 (59–117) | 141 ± 20‡ (87–178) | 104 ± 17 (72–139) |
| Girls ($n=37$) | 96 ± 10 (71–120) | 85 ± 10 (59–107) | 131 ± 15 (93–160) | 98 ± 12 (65–122) |

*Data are presented as mean ± standard deviation (range); †significant differences between groups at $p<0.001$; ‡significant differences between groups at $p<0.01$.

the XaviX bowling and XaviX J-Mat games were significantly higher in the boys compared to the girls ($p \leq 0.05$). Seventy-seven percent of the boys played the XaviX bowling game at a low intensity, compared to 32% of the girls. The remaining boys and girls played the XaviX bowling game at an intensity equivalent to sedentary. When playing the XaviX J-Mat game, 45% of the boys played vigorously, 53% played at a moderate intensity and the remaining 2% played at a low intensity. In comparison, 18% of the girls played the XaviX J-Mat game at a vigorous intensity, 67% played with moderate intensity and 15% played at a low intensity. No gender differences in RT3 counts existed for the internet video games.

Heart rate data were available for 77 of the 79 children. A significant main effect of play mode [$F(3,189)=9.503$, $p \leq 0.001$, $\eta^2=0.131$] was evident, but neither a main effect of gender nor an interaction were present. Follow-up analyses showed that heart rate was higher during the XaviX J-Mat game than either of the internet games or the XaviX bowling game ($p \leq 0.05$).

### *Reasons for choosing or ending a game*

Three themes (i.e., external influences, frustration, and internal feelings) emerged from the semi-structured interviews, and the number of times these themes were the reason for choosing or ending a game were counted. Play mode by gender RM ANCOVAs (with BMI as the covariate) were used to compare these choices by play mode and gender. When choosing which game to play, no main effects of play mode, gender or interactions were found for external influences or frustration. A main effect of play mode was found for internal feelings [$F(3,228)=5.463$; $p \leq 0.05$, $\eta^2=0.067$]. However, there was no main effect of gender and no interaction. Follow-up analyses showed that the predominant reason for choosing both exergames and the internet running game was attraction; however, the internet bowling game was chosen by some because they were attracted to it and by others because they were bored with the XaviX bowling game.

When play mode by gender RM ANCOVAs were used to compare reasons for ending a particular game, no main effects of play mode or gender were found for external feelings, internal feelings or frustration. There was a gender by play mode interaction for external influences [$F(3,228)=3.352$, $p \leq 0.05$, $\eta^2=0.42$]. The children generally ended the exergames and internet bowling game largely because they felt tired (in the case of the two exergames) or frustrated and bored (in the case of the internet bowling game). The exception was the internet running game, which the girls indicated they stopped playing because it had become frustrating or boring, but the boys indicated they stopped playing because they were distracted by the XaviX J-Mat game.

## Discussion

The findings from this study demonstrate that when given free choice, children split their total play time evenly between seated internet video games and exergames. Both video game modes (seated internet or exergame) were equally accessible and the even allocation of play time between the seated and exergame options would suggest that they were similarly attractive. The semi-structured interview data reinforce these findings, showing that attraction was a predominant reason for choosing to play both the exergames and seated internet video games. Surprisingly, we found no differences in the number or length of exergame play bouts engaged in by the boys and girls and with one exception, the boys and girls gave similar reasons for choosing to play or end a game. The boys did, however, play both exergames more intensely than the girls.

Video game play is profoundly gendered (Kafai et al. 2008). In many video media games, female character representations are either heavily gender stereotyped or missing altogether (Dietz 1998). Neither of the online games nor the XaviX J-Mat game had female characters. It has been suggested that both the characterizations within video media games and the game content may have a pronounced effect on the attitudes and behavioral expectations of children (Clarke & Duimering 2006; Sherry et al. 2006). Both boys and girls ended the XaviX J-Mat game because of fatigue. However, the boys ended the internet running game because they were distracted by the XaviX J-Mat game. The more physically demanding XaviX J-Mat clearly attracted the attention of the boys more so than the girls. The girls in this study may well have restricted their active behavior during the exergames because of the gender role expectations embedded within the characterization and content of these games, which may have lowered motivation and perceived reward. Men tend to perform better when playing video games that involve prolonged engagement in visual–spatial tasks and they have been found to show greater neural activation in the reward centers of the brain than women (Cherney & Poss 2008; Hoeft et al. 2008; West et al. 2008). The games utilized in the present study were simulated exercise games, with a visuospatial skill component and although we did not record game score, boys may have achieved more success and therefore derived greater reward from playing. Game performance may be an important factor for understanding why boys choose to play exergames more actively than girls and should be considered in future studies.

Although it is encouraging that the children in this study chose to use the exergames, these findings should be interpreted cautiously. This was the children's first exposure to the exergames. The attraction and reinforcing value of the exergames may diminish over time and reduce motivation for continued or future play. The effectiveness of using activity-promoting video games to combat the negative impact of sitting is dependent on the games being attractive enough long-term to be played regularly, for sufficiently long and in a manner that is activity-promoting. The XaviX bowling game was not activity-promoting in 68% of the girls and is unlikely to be a useful game for engaging girls in physical activity. Whilst the XaviX J-Mat was activity-promoting in all the children, it is discouraging that on first exposure, 27% fewer girls chose to play the game vigorously, with 12% of the girls playing only with low intensity effort. These findings have considerable implications for which games are used with whom. It may be that the XaviX J-Mat game would be successful in boys, but an alternative exergame is clearly needed for girls.

This study is not without limitations. First, the sample was a convenience sample that was relatively small, which limits the generalizability of the findings. Second, the exergames and seated video games used in this study were not identical. It is possible that the physically active component of the XaviX J-Mat game attracted the children to play it. Alternatively, differences in the virtual game experience between this and the internet running game may have influenced attraction. Previous work has shown that game content can modulate behavioral and attentional processes (Sherry et al. 2006; Dietz 1998). Whilst both games required the players to complete a journey by walking, running and dodging obstacles, the XaviX J-Mat game provided a visually more exciting experience as the game allowed the child to become "Jackie Chan" and to "fight against" ninjas. In contrast, the online running game provided a more simplistic graphical experience. It would be prudent to compare identical games, played seated and actively, to control for the influence of game content on child behavior. Future research to determine the effect of exergame on longer-term physical activity promotion in children is recommended (Biddiss & Irwin 2010; Foley & Maddison 2010).

To conclude, upon first exposure to a bowling and running exergame, both girls and boys choose to play them for similar reasons and for similar periods of time. The boys, however, played both more actively and there was some indication that the more active exergame attracted the attention of the boys more so than the girls. Finding exergames that attract girls and motivate equally active play will be important if these games are to become suitable for longer-term physical activity promoting interventions in girls.


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