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The differences between less fit and overweight children on enjoyment of exergames, other physical activity and sedentary behaviours

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Abstract

Converting sedentary screen-time into active screen-time might provide an effective way to encourage children to accumulate more health-related physical activity. However, there is little empirical evidence available to determine whether children enjoy exergames equally or more than, traditional sedentary activities or traditional physical activities. Therefore, the purpose of this study was to determine the differences between less fit and overweight children on enjoyment of several activities including one sedentary activity (playing PS3 game), two exergames (Xbox Kinect Bowling and Wii Tennis) and one physical activity (running). One hundred and sixty-two children, aged 11.2±0.8 years were divided into two groups (normal weight and overweight) according to their weight status (BMI). Participants individually attended three testing sessions during which they performed baseline measures and several physical activities as describe above. Following each activity children completed a Physical Activity Enjoyment Questionnaire. A two-way analysis of variance (ANOVA) with repeated measures was conducted to evaluate the effect of weight status on the enjoyment of those activities. Results indicated that running was the least enjoyable activity whereas the exergame, Wii Bowling, was the most enjoyable activity. Children ranked the two exergames as the most enjoyable activities irrespective of weight status. No significant differences were found between groups. Conclusively, children's enjoyment of exergames could be capitalised on in order to develop interventions to increase physical activity.

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Keywords: exergames; enjoyment; physical activity; sedentary behaviours; overweight children

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1. Introduction

The public health crisis of physical inactivity is reaching epidemic proportions (Biddle, Gorely&Stensel, 2004). The health benefits associated with proper levels of physical activity are well documented, however a large percentage of the population is not sufficiently active to attain those health benefits (Tzetzis, Avgerinos, Vernadakis&Kioumourtzoglou, 2001). Physical inactivity, defined as engaging in minimal physical activity and failing to achieve even the most basic of activity guidelines (Legh-Jones& Moore, 2012), is a major contributor to the global burden of chronic health disease. World Health Organisation (WHO) data suggests that there is a significant proportion of the global population who are classified as inactive (World Health Organisation, 2011). Alarmingly, it is apparent that physical inactivity does not pertain to the adult population alone (Biddle et al., 2004). An increasing amount of data is indicating that a significant proportion of children are inactive too (Duncan, Al-Nakeeb, Woodfield& Lyons, 2007; McManus&Mellecker, 2012). Of equal concern is data which shows that children are spending a significant proportion of their days involved in sedentary behaviour (Maitland, Stratton, Foster, Braham &Rosenberg, 2013; Owen, Healy, Matthews& Dunstan, 2010). Sedentary behaviour, defined as activity which requires low levels of energy expenditure (EE) and minimal bodily movement (Owen et al., 2010), may be contributing to chronic health diseases in children (Hamilton, Hamilton&Zderic, 2007). Chronic health diseases such as type 2 diabetes, hypertension and obesity, which were once classified as 'adult' diseases, are now prevalent in children (Popkin, Adair& Ng, 2012).

There are a number of contributing factors to childhood physical inactivity and sedentary behaviourwhich include a decline in physical education and physical activity offered by schools, changes in urbanisation and transportation and the increase in the amount of time children spend participating in sedentary leisure based activities (Hamlin & Ross, 2005). In addition, media rich home environments promote activities such as watching television, playing computer games and playing video games. According to Meier, Hager, Vincent, Tucker, & Vincent, (2007) sedentary leisure based activities screen-based activities form a significant part of a child's leisure time.

Although most of the sedentary behaviour research has focused on television viewing, home-based video games are another sedentary behaviour which may be indirectly contributing to obesity and health diseases in children. Traditionally, these games have been equally considered as sedentary as watching television (Lyons et al., 2012). However, recently the gaming world has been revolutionised by the introduction of exergaming systems such as Nintendo Wii Sports, Xbox Kinect and PlayStation EyeToy. These gaming systems offer the opportunity for players to actively play the games, requiring part or whole-body movement (Vernadakis, Gioftsidou, Antoniou, Ioannidis &Giannousi, 2012). Therefore, compared to traditional sedentary-style games, it seems plausible that there may be benefits in encouraging young adults to play active video games at least in terms of increasing daily energy expenditure.

Previous studies have found that a higher level of energy expenditure is produced when playing exergames than when engaging in sedentary activities (Graf, Pratt, Hester, &Short, 2009; Graves, Stratton, Ridgers, & Cable, 2008). Playing exergames has also resulted in increased motivation for participating in real sports (Klein & Simmers, 2009). Similarly, Brubaker (2006) found that overweight children, playing DDR at least five times per week showed better psychomotor coordination and stronger self-esteem. In turn, they were likely to begin exercising more regularly. Furthermore, White, Kilding, & Schofield (2009) found that all of the Wii Sport active video games (Tennis, Boxing and Bowling) were significantly more enjoyable than walking, watching television and running.Vernadakis, Derri, Tsitskari& Antoniou (2014) reported that the use of the Xbox Kinect intervention is a valuable, feasible and pleasant approach in order to improve balance ability of previous injured young competitive male athletes compared to the traditional approach. Finally, Penko& Barkley (2010) found significantly greater reinforcement for the exergame in lean children whereas the exergame was equally as reinforcing as the sedentary game in obese children.

Considering the above research effort, it seems worthwhile to determine whether children enjoy exergames equally or more than, traditional sedentary activities or traditional physical activities. Therefore, the purpose of this study was to determine the differences between less fit and overweight children on enjoyment of several activities including one sedentary activity (playing NBA 2K13-PS3 game), two exergames (Xbox Kinect Bowling and Wii Tennis) and one physical activity (running).The study looked into the following main research statements:

- Are there differences in mean enjoyment scores between the normal weight and the overweight groups?

- Do children, on average, report differently on the enjoyment scale for the running, NBA 2K13-PS3, Xbox Kinect Bowling and Nintendo Wii Tennis activities?
- Do the differences in means for the enjoyment between the normal weight and the overweight groups vary between the running, NBA 2K13-PS3, Xbox Kinect Bowling and Nintendo Wii Tennis activities?

2. Method

2.1. Participants

One hundred and sixty-two children (85 boys and 77 girls), aged 11.2±0.8 years were recruited for the study through personal contacts, local schools, and community advertisements. Children were classified into two groups, normal weight and overweight, based on Cole et al.'s (2000) Body Mass Index (BMI) cut off points. Prior to group assignments, children of parents expressing interest were screened to ensure they were willing to participate after being informed of the full study responsibilities.Exclusion criteria included children who were not healthy (for example, those suffering from coughs and colds), injured, had asthma, or were not able to exercise at moderate to high intensities.Informed consent was obtained from each parent of the young children prior to their voluntary participation in the study.

2.2. Enjoyment instrument

A 16-item Physical Activity Enjoyment Scale was used to determine the extent to which the activity was enjoyed by the participants (Motl et al., 2001). The scale included a series of statements such as: I disliked it, It frustrated me, It felt good, It made me unhappy. Participants were required to indicate how much they identified with the statement by giving a numerical rating on a Likert-type scale anchored by 1 (disagree a lot) to 5 (agree a lot). This instrument has been shown to have construct and internal validity and reliability ($r=0.75$, $p<0.01$) (Davison, Werder, Trost, Baker, & Birch, 2007). Negatively worded items were reverse coded. Total enjoyment was recorded as the mean of the 16 items.

2.3. Procedure

Participants individually attended three testing sessions during which they performed different tasks (Table 1). During session 1, participants completed the running activity. The running activity was performed in an indoor sports stadium. Participants were instructed to run around a 50m circuit for 3-minutes at a pace they could maintain for the duration of the time.Baseline measures, including height and body mass, were taken before participants completed the running activity. The session 2 began with a 20-minutesfamiliarisation period to ensure that all children were accustomed to the range of video games. The familiarisation period was followed by 10-minutes playing a sedentary video game (NBA 2K13 - PS3). During session 3 participants completed two exergames (Xbox Kinect Bowling and Nintendo Wii Tennis)which were played for 10-minutes each. The exergames included in the study were chosen to represent a range of activity levels which required upper, lower or combined upper and lower body movements. Participants were given a 3-minute break between all activities during which they answered questions relating to their enjoyment of the activity.All of the activities, with the exception of running, were carried out in the same standardised environment.

Table 1.Outline of testing sessions.

Session 1	Session 2	Session 3
Baseline height & weight	Games familiarisation	Exergame 1 (Xbox Kinect Bowling)
Running at a self-selected pace	Sedentary activity (NBA 2K13 - PS3)	Exergame 2 (Nintendo Wii Tennis)

2.4. Data analysis

Normality of distribution was tested with the Kolmogorov-Smirnov test. Homogeneity of variance and Sphericity was verified by the Box's M test, the Levene's test and the Mauchly's test (Green &Salkind, 2007). A two-way analysis of variance (ANOVA) with repeated measures was conducted to evaluate the effect of weight status and type of activity on enjoyment. The dependent variable was enjoyment. The within-individuals factors were weight status groups with two levels (normal weight, overweight) and type of activity with four levels (running, PS3, Xbox Kinect, Nintendo Wii). The weight status x type of activity interaction effect, as well as the weight status and type of activity main effect were tested using the multivariate criterion of Wilks's lambda (Λ). Significant differences between the means scores were tested at the 0.05 alpha level. An effect size was computed for each analysis using the eta-squared statistic (η2) to access the practical significance of findings. Cohen's guidelines were used to interpret η2 effect size: 0.01=small, 0.06=medium and 0.14=large (Cohen, 1988).

3. Results

Table 2 shows the means and the standard deviations for the normal weight and overweight groups on enjoyment of several activities including one sedentary activity (NBA 2K13-PS3 game), two exergames (Xbox Kinect Bowling and Nintendo Wii Tennis) and one physical activity (running).

Table 2.Means and standard deviations for the normal weight and overweight groups on enjoyment of several activities.

Activity	Group	N	Mean	Std. Deviation
Running	Normal weight	81	3.55	1.01
	Overweight	81	3,48	1.11
NBA 2K13 – PS3	Normal weight	81	3,88	1.10
	Overweight	81	3,97	1.28
Xbox Kinect Bowling	Normal weight	81	4.48	.87
	Overweight	81	4.33	.94
Nintendo Wii Tennis	Normal weight	81	4.37	.96
	Overweight	81	4.28	.94

3.1. Enjoyment comparison

Two-way analysis of variance (ANOVA) with repeated measures was conducted to evaluate the effect of weight status and type of activity on enjoyment. The enjoyment comparison showed a significant main effect for the type of activity, Λ=0.313, F(3, 158)=114.08, p<0.001, partial η^2=0.687, while the weight status x Type of activity interaction effect was not significant, Λ=0.961, F(3, 158)=10.24, p=0.104, partial η^2=0.039. The univariate test associated with the weight status group's main effect was also not significant, F(1, 160)=0.143, p=0.706, partial η^2=0.001. Pairwise comparisons using t-test with a Bonferroni adjustment were conducted to follow up the significant type of activity main effect and assess differences across activities on enjoyment. Results revealed significant mean differences in enjoyment scores between the running physical activity and the other three activities, NBA 2K13-PS3 (*MD*=-0.413; 95% *CI*: -0.549 to -0.276, p<0.001), Xbox Kinect Bowling (*MD*=-0.892; 95% *CI*: -1.023 to -0.762, p<0.001) and Nintendo Wii Tennis (*MD*=-0.812; 95% *CI*: -0.974 to -0.651, p<0.001). Moreover, significant mean differences in enjoyment scores were found between the NBA 2K13-PS3 sedentary activity and both the exergames activities of Xbox Kinect Bowling (*MD*=-0.480; 95% *CI*: -0.613 to -0.347, p<0.001) and the Nintendo Wii Tennis (*MD*=-0.400; 95% *CI*: -0.551 to -0.249, p<0.001). As shown in Figure 1, the exergames were consistently ranked among the top two activities irrespective of the children's weight status.

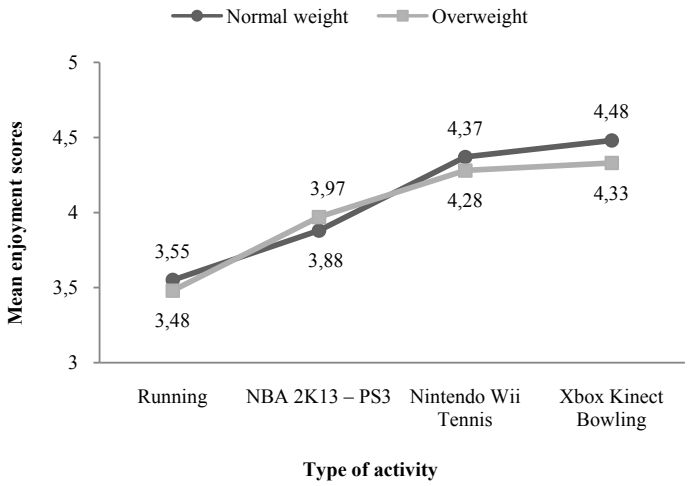

Fig. 1.The effect of weight status and type of activity on enjoyment.

4. Discussion

Converting sedentary screen-time into active screen-time might provide an effective way to encourage children to accumulate more health-related physical activity.Therefore, the purpose of this study was to determine the differences between less fit and overweight children on enjoyment of several activities including one sedentary activity (playing NBA 2K13-PS3 game), two exergames (Xbox Kinect Bowling and Wii Tennis) and one physical activity (running). Results showed that children enjoyed playing exergames. Children ranked the two exergames as the most enjoyable activities irrespective of weight status (Fig.1). The most enjoyable activity, Xbox Kinect Bowling, was enjoyed significantly more than all other activities, excluding Wii Tennis, thus suggesting that there is a strong preference towards this game. The activity least enjoyed by the participants was running. The sedentary video game (NBA 2K13-PS3) was ranked as the third most enjoyable activity,after the two exergames. This suggests that the children had a strong preference towards the exergames over the traditional video game. This is important to consider, as even if children are given the opportunity to play sedentary video games they may still choose exergames over the traditional video games. Intervention studies are needed to determine which type of games children prefer to play when given an option.

Based on the research and the analysis of the data, this study revealed that exergames may provide children with a unique opportunity to increase their amount of daily physical activity. They are enjoyable and conducive to being played within the home environment. As active video games are able to be played indoors they may be a good substitute for sedentary behaviour during times when children are least active e.g. after school, on weekends and during winter (Bebetsos& Antoniou, 2009). Exergaming has been shown to provide players with an enjoyable exercise experience (Vernadakis et al., 2014) as they tend to view exergaming more as entertainment rather than exercise (Klein & Simmers, 2009). It is possible that the entertainment element of exergaming may have played a role in influencing participants' attitudes toward physical activity.

A possible reason why the exergames may be considered more enjoyable than running and playing NBA 2K13-PS3 video game irrespective of weight statusis because they may provide more mental stimulation and challenge for participants. Due to the nature of the exergames they may also be considered to be unstructured physical activity. Therefore, the children may have not perceived themselves to be participating in physical activity when they were playing the exergames.

5. Conclusion

In conclusion, exergames are more enjoyable than running and traditional video games. Enjoyment of exergames was clearly evident irrespective of weight status. Children's apparent enjoyment of exergames and electronic media should be capitalised on by those designing interventions to reduce sedentary behaviour. However, future studies are needed to track children's long term enjoyment of exergames.

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