Medicina Sportiva
Med Sport 16 (3): 92-98, 2012
DOI: 10.5604/17342260.1011386
ICID: 1011386

ENERGY EXPENDITURE AND ENJOYMENT OF EXERGAMING: A COMPARISON OF THE NINTENDO WII AND THE GAMERCIZE POWER STEPPER IN YOUNG ADULTS

Michael J. Duncan[A,B,C,D,E,F], **Samantha Dick**[B,D,E,F]

Department of Biomolecular and Sports Science, Coventry University, UK

Abstract

Objective: To compare Energy Expenditure (EE) and enjoyment responses in sedentary gaming, brisk walking and exergaming using the Nintendo Wii and the Gamercize Power Stepper.

Methods: EE, steps taken and enjoyment was assessed during sedentary gaming, brisk treadmill walking and two forms of exergaming in 30 young adults (aged 18-30, Mean age ± S.D. = 21.3 ± 2.4 years, 14 males, 16 females).

Results: EE and steps taken were significantly higher during Gamercize Power Stepping ($P < 0.0001$) compared to other conditions. Nintendo Wii EE was significantly greater than sedentary gaming EE but similar to brisk walking. A significant activity by gender interaction for enjoyment ($P = 0.012$) indicated that brisk walking was rated as less enjoyable by males compared to all other modes of gaming ($P < 0.05$). In females, Nintendo Wii activity was rated as more enjoyable than all other activities($P < 0.05$).

Conclusion: Exergaming results in moderate intensity activity, and is rated as enjoyable in young adults. Thus providing a stimulus for modification of typically sedentary behaviour to a more active alternative.

Keywords: *Nintendo Wii; physical activity; video games*

Introduction

A range of research has highlighted sedentary pastimes including television and video gaming as significant influences on physical activity (PA), sedentariness and weight status in children, adolescents and adults [1,2]. However, technological advances over the last 5-10 years have led to the development of activity-based interactive video games (also known as 'exergaming') such as dance mats, Nintendo Wii and, more recently, Xbox Kinect. One suggestion has been that exergaming could contribute to increasing energy expenditure (EE), converting sedentary screen time to active screen time and potentially reducing obesity in various populations [3-5].

However, while sales of interactive video game consoles have surpassed traditional sedentary gaming consoles, there are limited data on the physiological cost, of these interactive games [6]. There has also been no adequately powered randomised controlled trial to date limiting the ability to make conclusions regarding the positive effects or long term sustainability of exergaming in discrete populations [7].

Of the extant studies available, the majority have concluded that EE during active videogaming is greater than that accrued during sedentary gaming, but may not be not sufficient for health benefit in children [3,4,8]. Conversely, adult based research by Willems and Bond [9] reported that Nintendo Wii boxing resulted in similar oxygen uptake, heart rate and EE responses to self-paced brisk walking. This has also been supported by pediatric research where active videogaming resulted in a 2-3 fold increase in EE to watching television and was comparable to moderate intensity treadmill walking (5.7 km/h) in 24, 10-13 year olds [8].

More recent research by Graves et al. [10]. built on earlier studies by examining physiological cost and enjoyment of Wii Fit activity in adolescents, young adults and older adults. Irrespective of population, Wii fit activity increased EE and heart rate compared to sedentary gaming but was lower than EE accrued during brisk walking and jogging on a treadmill at a self selected pace. Wii aerobics elicited moderate intensity activity in their participants and the researchers concluded that Wii Fit was rated as an enjoyable exergame that stimulates light-to-moderate intensity activity [10]. This latter point is important as enjoyment of a physical activity is a key determinant influencing the allocation of time to that pursuit [11,12] Specifically, if people enjoy exergaming, participation in this behaviour over a prolonged period may ultimately benefit PA engagement and accrual [10]. However, to date, only one study [10] has examined enjoyment of exergaming and in this study only Nintendo Wii Fit was examined. With the increasing advances of exergaming technology it is important for research-

ers to not only assess EE of the range of exergaming modalities but also participants' enjoyment of these to understand whether exergaming may have a place in PA prescription.

Consequently, the potential of exergames to contribute to enhancing EE is unclear. Part of this incongruence is due to the range of video game systems that have been examined in the literature and variations in the assessment of physiological cost [13]. More recently, work by Jordan et al. [6] examined EE in 15 male adults during 12 minutes of Nintendo Wii boxing, walking at 5.6 km/h, cycling at 120W, sedentary gaming and Playstation 2 gaming using an adapted controller that required lower limb movement. They found that use of the limb controlled gaming system resulted in six times greater EE than sedentary gaming with corresponding CHO and Fat oxidation rates, 5 and 10 times greater respectively. Limb controlled gaming met ACSM guidelines for cardiovascular fitness whereas Nintendo Wii gaming did not. Jordan et al. [6] concluded that exergame technology has the potential to contribute to increasing EE for health benefit in adults but it must be adapted or designed to include the lower limbs in order to provide a significant exercise stimulus.

One novel exergaming system, the Gamercize Power Stepper, may provide a viable means by which to convert sedentary EE to active EE using lower limb movement. This system consists of an exercise stepping machine which interfaces with commonly available video game systems and their controllers. Participants must step on the Gamercize power stepper at a minimum cadence of 30 steps/min in order for the videogames controller to remain active and thus enable the participant to play the videogame system. Such a system has the potential to contribute to daily PA and EE but, to date, no study has assessed EE whilst using the Gamercize Power Stepper either in comparison to traditional PA or other exergaming systems.

Therefore, the aim of this study was to evaluate the EE and enjoyment of young adults while playing Nintendo Wii and Gamercize exergaming technology, compared to sedentary video gaming and brisk treadmill walking.

Methods

Participants

Thirty young adults (18-30, Mean age ± S.D. = 21.3 ± 2.4 years, 14 males, 16 females] visited the laboratory on 2 occasions to complete a familiarisation and experimental trial. Participants were recruited via word of mouth and all had experience of video game technology in general and active video gaming specifically. 90% owned a Nintendo Wii or Microsoft XBox, and participants reported playing video games on average 2-3 times per week for between 1-3 hours per gaming session via a pre-exercise gaming questionnaire. Participants gave written informed consent and the study was approved by institutional ethics committee. Data collection took place in October-November 2012.

Familiarisation

Stature was measured to the nearest 0.1cm and body mass to the nearest 0.1kg using a Seca stadiometre and scales (Seca Instruments, Germany). Participants were then familiarised with the gaming technology to be employed in the experimental trial. Familiarisation procedures were congruent with prior studies that have used similar methodology [9,10]. For sedentary gaming, participants played Fifa football 2010 for 5 minutes on the Microsoft Xbox. For Nintendo Wii, participants played Just Dance for 5 minutes and for Gamercize familiarisation, participants were required to play Fifa football 2010 on the Microsoft Xbox whilst stepping continually on the Gamercize Power Stepper in order to power the game controller.

For motorised treadmill familiarisation, participants were asked to 'walk briskly' at a self selected speed for 5 minutes each. Mean ± S.D. of self selected walking speed was 6.0 ± 0.9 km/h. Following activity familiarisation participants were introduced to the items they would respond to on the modified Physical Activity Enjoyment Scale (PACES) [14] and encouraged to raise any concerns regarding the 4 experimental conditions.

Experimental trial

Participants were fitted with a Sensewear arm band (SWA; BodyMedia, Inc, Pittsburgh, PA) and performed each of the following activities in the order listed, interspersed with 10 minutes seated rest: Sedentary Gaming, Nintendo Wii Just Dance, Gamercize Power Stepper and treadmill walking. This order was used as it is similar to prior research [10] and, like Graves et al. [10], was perceived to represent a progressive increase in exercise intensity. Following each activity, participants completed the modified PACES. A 10 minute rest period was chosen as this was sufficient for participants to return to resting levels in between the different gaming conditions. In the prior work by Graves et al. [10], a 5 minute rest period was used. However, in our pilot testing a 10 minute rest ensured that heart rate had fully returned to pre exercise levels and that there was no residual carryover in PACES scores from the preceding gaming/exercise condition.

For sedentary gaming participants played Fifa football 2010 or Sega Superstars Tennis set on the easiest setting. Once a game finished the activity was restarted and continued throughout the 10 minutes. For the Nintendo Wii condition, participants played Just Dance for the 10 minute period. Fifa football 2010 and Sega Superstars Tennis were also used during the

Gamercize Power Stepper condition with participants required to step at a minimum cadence of 30 steps/min in order for the video game system to continue working. For brisk walking participants exercised at the self-selected speeds determined at familiarisation.

Instruments

Energy Expenditure. EE and steps taken during the four conditions was assessed using a SenseWear Armband (SWA; BodyMedia, Inc, Pittsburgh, PA) worn on the upper arm in accordance with manufacturer's guidelines and following initialization of the armband via the InnerView Research Software (BodyMedia, Inc). The SenseWear Armband is worn on the upper arm and collects a variety of physiologic data through multiple sensors (a two-axis accelerometer, heat flux sensor, skin temperature sensor, near-body ambient temperature sensor and galvanic skin response sensor) which is then uploaded and analyzed using specific computer software. This multiple sensor array was designed to overcome the limitations of other objective EE assessment tools [15] and the SenseWear armband has been shown to be a valid and reliable measure of EE and ambulatory activity at rest and during exercise [15-17]. For example, estimates EE from other objective measures such as accelerometry may not be sensitive to activities such as cycling or upper body only exercise due to the way in which the accelerometry mechanism works. Likewise, estimating EE from heart rate can prove problematic due to assumptions regarding a linear heart rate- EE relationship and because elevated HR may not be the sole result of increased EE. Thus, the SenseWear armband provides a more robust estimate of EE because the multiple sensors utilise six streams of physiological data to provide valid and reliable estimates of EE from sleeping to high intensity exercise [15].

Physical Activity Enjoyment Scale. Congruent with the only other study to examine enjoyment during exergaming [10], a modified PACES (14] determined the enjoyment while undertaking the activities, with 5 items from the original 18 items being included in the study. The modified PACES was the same as that used by Graves et al. [10], to reflect the study aims and to enable direct comparison with the only other published study on this topic. This provided a means by which to directly compare enjoyment between the current study and the only other published study on this topic. The original PACES included items relating to affective balance, life fulfilment and consequences of enjoyment. Given the acute nature and focus of the study these were removed in line with the prior work of Graves et al. [10]. For the PACES Individuals rated the extent to which they agreed with each item on a 7-point likert type scale. For each activity, for each participant, total responses were summed to give a score ranging from 5 to 35, and a percentage enjoyment scale was calculated. The PACES has been found to be reliable and valid in physical activity environments [14]. In the present study, reliability of the 5 items were high for each activity (Cronbach's *alpha* all ≥ 0.74).

Statistical analysis

Energy Expenditure (kcal), total steps and enjoyment scores were examined using a series of repeated measures analysis of variance (ANOVA) with gender as the between-subjects factor and activity (Sedentary Gaming, Nintendo Wii Gaming, Gamercize Power Stepping and Brisk Treadmill Walking) as the within-subjects factor. Where any significant differences were found Bonferroni post-hoc pairwise comparisons were used to determine where the difference lay. The Statistical Package for Social Sciences (SPSS, Version 17) was used for all analysis with statistical significant set at $P < 0.05$ a priori.

Results

For EE, a significant main effect was evident (F3, 84 = 58.37, $P = 0.0001$) but there was no significant gender by activity interaction ($P > 0.05$). Bonferroni post-hoc multiple comparisons indicated that EE was significantly higher for the Gamercize power stepping condition compared to sedentary gaming (Mean Diff = -41.05, $P = 0.0001$), Nintendo Wii activity (Mean Diff = -18.45, $P = 0.001$) and brisk treadmill walking (Mean Diff = 7.85, $P = 0.006$). Nintendo Wii activity EE was significantly greater than sedentary gaming (Mean Diff = 22.6, $P = 0.0001$) but was similar to treadmill walking. Likewise, treadmill walking resulted in greater EE than sedentary gaming (Mean Diff = 33.2, $P = 0.0001$).

In regard to the total steps undertaken during each activity, data followed a similar trend to that described for energy expenditure (F3, 84 = 271.8, $P = 0.0001$). Post-hoc tests revealed significant differences between all conditions (all $P = 0.0001$) with the highest steps counts obtained during Gamercize Power Stepping followed by brisk walking, then Nintendo Wii and with sedentary gaming resulting in a minimal accrual of steps, as could be expected. Mean ± S.D. of Energy Expenditure (Kcal) and total steps for each activity condition are presented in Table 1.

In regard to enjoyment, a significant activity by gender interaction was evident (3, 84 = 4.023, $P = 0.012$, See Fig. 1.). One-way ANOVAs for each gender group indicated that enjoyment was significantly lower for brisk treadmill walking in males compared to Nintendo Wii activity (Mean Diff = 8.33, $P = 0.01$), Gamercize Power Stepping (Mean Diff = - 7.00, $P = 0.05$) and sedentary gaming (Mean Diff = 7.00, $P = 0.01$) but was similar for all three forms of videogaming with Nintendo Wii activity having the highest

Table 1. *Mean ± S.D. of energy expenditure, steps taken and enjoyment across gaming and brisk walking conditions*

	Nintendo Wii		Gamercize Power Stepper		Sedentary Gaming		Brisk Treadmill Walking	
	M	S.D.	M	S.D.	M	S.D.	M	S.D.
Energy Expenditure (Kcal)	37.8	21	56.2	14.5	15.4	5.7	48.5	10.1
Steps	374.6	282.1	1168.4	149.8	6.1	4.4	981.1	120.9
Enjoyment	30.7	4.1	26.4	4.8	24.5	5.9	22.3	5.5

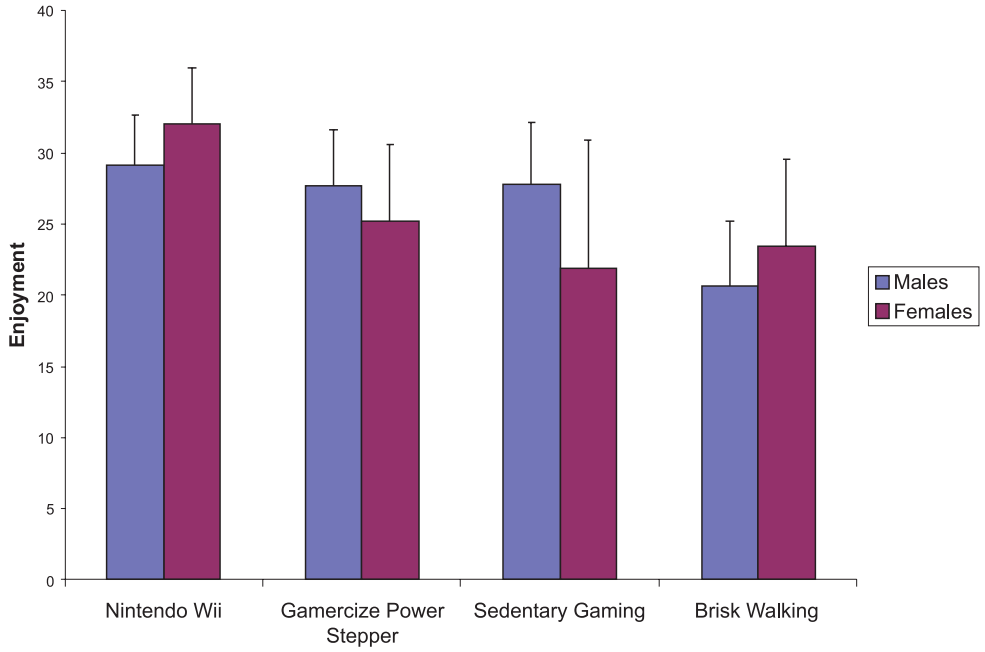

Fig. 1. *Mean ± S.D. of enjoyment scores across gaming and brisk walking conditions for males and females*

score. However, for females, enjoyment was significantly higher for Nintendo Wii activity compared to Sedentary gaming (Mean Diff = 10.1, $P = 0.01$), brisk treadmill walking (Mean Diff = 8.5, $P = 0.02$) and Gamercize power stepping (Mean Diff = 4.1, $P = 0.05$).

Discussion

The current study compared EE and enjoyment of young adults whilst playing on the Nintendo Wii, Gamercize Power Stepper, during sedentary videogaming and brisk treadmill walking. For all participants, EE was greater than sedentary gaming, congruent with other studies on exergaming [3,4,8-10]. The current results from a population of young adults also suggest that EE on Gamercize Power Stepper was significantly greater than that accrued during Nintendo Wii activity and brisk treadmill walking. Nintendo Wii EE was similar to EE during brisk walking. No studies have examined EE when using the Gamercize Power Stepper, thus making it difficult to draw parallels with prior studies. However, the current results are contrary to recent work by Graves et al. [10] which found Nintendo Wii activity to be greater than that accrued during brisk treadmill walking but similar to work by Willems and Bond [9] which reported Nintendo Wii activity to be similar in terms of metabolic cost to treadmill walking. The equivocal nature of the results of the present study and prior research may be due to a number of factors. Exergaming by nature is intermittent [18] and has been cited for energy cost disparities between exergaming and brisk walking [10]. Also, although prior studies are disparate in regard to the energy cost of Nintendo Wii activity compared to brisk treadmill walking, this may be due to the game titles included in each respective study. Work by Graves et al. [10] employed Nintendo Wii Fit and research by Willems and Bond [9] examined Nintendo Wii Sports. This is compared to the current study where the game title Just Dance was employed. Clearly, different games may result in different work: rest ratios during game play. Researchers therefore should be clear regarding the game titles employed in exergaming studies as no

gold standard game title is available as a benchmark for studies of this nature.

Similarly, the mode of brisk treadmill walking at a self-selected pace, as used in the present and prior studies [9,10] could also explain some of the differences found across studies. Brisk treadmill walking is considered a moderate intensity exercise [19] The average walking speed chosen by participants in the present study (5.7 km) was similar to brisk walking speeds reported previously for young adults [20] and is similar to speeds reported in prior studies of exergaming [9,10]. In all cases, data indicate that the brisk walking conditions employed in this study and prior work was moderate in nature. Thus, it may be that game title is key if using exergames as a means to enhance or increase PA in a given population.

Nevertheless, in the present study, both exergaming conditions (Nintendo Wii, Gamercize Power Stepper) resulted in EE that was moderate in nature. This finding is comparable to a range of prior studies using different exergaming platforms and titles [9,10,14,21]. These findings agree with prior assertions that, as yet, vigorous activity has yet to be elicited through exergaming [4,10]. However, in the current study, both Nintendo Wii and Gamercize Power Stepping activity would contribute to recommendations for health benefiting PA in adults [22]. This is important as encouraging moderate intensity activity may help reduce the risk for all-cause mortality and a range of hypokinetic disease processes including coronary heart disease [22]. Furthermore, promoting exergaming activity is arguably positive in that it is replacing traditionally sedentary behaviour with activity.

In regard to the two exergaming platforms employed in the present study, EE during Gamercize Power stepping was significantly higher (Mean Diff = 18.45 Kcal), than that accrued during Nintendo Wii activity. Furthermore, there was far less variation in EE during the Gamercize Power Stepping Condition as compared to the Wii condition. Recent research By Jordan et al. [6] identified that significant lower limb activity was needed to elicit consistent and higher EE during exergaming and suggested that exergaming platforms utilising lower limb movement would be best placed to provide exercise stimulus for health benefit. The results of the present study would clearly support these claims. The higher EE and smaller variation for the Gamercize Power Stepping condition in the present study are likely due to the mechanism by which this particular gaming system works. Most exergames require the player to interact within the video game itself with PA accrued as part of this process. However, with the Gamercize Power Stepper, players can play any videogame title that would otherwise be used in a sedentary gaming mode but, in order to play the game, must maintain a constant stepping cadence for the system to remain active. Thus, the nature of activity when using this system is less intermittent than other exergaming systems and is not influenced by the game title being played. The psychological basis on which this is based is clearly different from systems being more in line with behaviourism rather than using a task mastery approach to elicit PA such is the case with the Nintendo Wii. As the Gamercize system enables individuals to play sedentary video game titles whilst necessitating stepping in order to play, it may be that this system is more suited to converting sedentary screen time to active screen time in individuals where considerable amounts of leisure time are spent playing video games. Given the proportion of time spent playing video games by young adults [23], this may merit further investigation.

Enjoyment scores in the present study may also be important in considering the potential efficacy of exergaming as a viable means to enhance leisure time PA. There was a condition by gender interaction in the present study. This indicated that males rated all forms of video gaming (Nintendo Wii, Gamercize Power Stepping and Sedentary Video Gaming) as significantly more enjoyable than brisk treadmill walking. However, for females, Nintendo Wii activity was rated as significantly more enjoyable than all the other modes of activity in the current study. These results broadly agree with the only other study that has reported enjoyment scores during exergaming[10] in that Nintendo Wii activity was rated as more enjoyable than brisk treadmill walking. However, no study to date, has reported gender differences in exergaming enjoyment.

Enjoyment is an important determinant influencing the time an individual allocates to an activity [12] and activity such as brisk treadmill walking can lead to boredom [24], which is not viewed as an enjoyable state [25]. It is therefore imperative that, for sustainable PA behaviour, PA should be enjoyable. From a public health perspective, changing the PA behaviour of inactive individuals might be best accomplished by offering opportunities to engage in enjoyable PA, rather than more traditional forms of aerobically based exercise where adherence may be compromised due to lack of enjoyment. If exergaming is perceived to be enjoyable, particularly by those who regularly engage in sedentary gaming, individuals might be more likely to sustain participation in light-to-moderate intensity exergaming [10]. The condition by gender interaction found in the present study might also be important here as males reported both modes of exergaming to be as enjoyable as sedentary gaming whereas for females, Nintendo Wii activity was significantly more enjoyable than all other modes of activity in the study. This may indicate that for males, sedentary gaming could be relatively easily converted to exergaming with no reduction in enjoyment but an increase in EE during

gaming activity. For females however, it may be that the kinaesthetic nature of Nintendo Wii gaming or the nature of the game used in the current study made it more enjoyable than the other activities examined here. Although, at face value, this seemingly indicates that females may be more receptive to Nintendo Wii as an exergaming platform, caution is needed with these results. Pre experiment gaming questionnaires revealed that all participants owned and regularly played a video games console. However, all the females in the study owned a Nintendo Wii, whereas there was a mixture of systems owned by the male participants. Prior research has reported that gaming experience is important when examining responses to exergames [26]. It may be that familiarity with the Nintendo Wii and/or the game title employed contributed to the enjoyment scores for female participants in the study and future research would benefit from exploring the qualitative experiences of and perceptions of enjoyment of exergames taking this into account.

Limitations

There are also a number of limitations of the current study. A relatively small and homogenous sample took part in this research. This is at least similar to, and in many cases larger than, sample sizes used in similar studies [3,4,9,10,18] but further research is needed with a larger, more heterogeneous sample in terms of age, gaming experiences and habitual physical activity levels in order to make recommendations regarding the suitability of exergaming as a viable means to augment PA from a public health perspective.

The sample employed in the present study was based on volunteers and, similar to other studies [9,10], enjoyment responses may be biased compared with those who did not volunteer. Generalisation of these findings to other populations should therefore be made with caution. Furthermore, as 90% of the participants owned a Nintendo Wii of XBox, their prior experiences with the Nintendo Wii platform may have influenced their perception of enjoyment in comparison to the gamercize power stepper, where they were all unfamiliar with this mode of active gaming. However, given the widespread use of Nintendo Wii with young people, it is unlikely that a population group could have been sampled from this demographic who had not had prior experiences with this form of active gaming. There is also remit for future research to use more ecologically valid physical activities as a comparison with exergaming. Treadmill based brisk walking was employed as a comparative due to its feasibility and because it represents typical daily activities. It also enabled comparison with similar previous studies. However, enjoyment of treadmill walking may be quite different from walking in other environments (e.g., park) and future research may benefit from comparing exergaming enjoyment with other modes of PA such as cycling, aerobic exercise classes etc to provide a more ecologically valid comparison.

Congruent with prior research on this topic, the short duration of participation in each condition provides information on the acute EE and enjoyment responses during these activities. However, if exergaming is to be considered a viable means to modify PA behaviour in sedentary individuals or as an alternative way for people to accrue daily PA, longitudinal, field-based studies are needed to determine the longevity of EE and enjoyment in exergaming.

Conclusions

Energy Expenditure during exergaming was significantly higher than sedentary gaming. Nintendo Wii EE was similar to EE during brisk treadmill walking but EE accrued when using the Gamercize Power Stepper was significantly greater than that achieved during Nintendo Wii or treadmill walking activity. Intensities of activity during both modes of exergaming were within daily health-benefiting PA recommendations for young adults. Acute enjoyment scores across modes of conditions indicated a gender difference with females rating Nintendo Wii activity as significantly more enjoyable than brisk walking, Gamercize Power Stepping and sedentary gaming. However, for males, all forms of gaming (exergaming and sedentary gaming) were not significantly different but all significantly higher than brisk walking. These results suggest that exergaming may be a viable alternative to traditional forms of PA as a means of increasing daily EE.

Declaration of interest

The authors report no conflicts of interest.

References

1. Varo JJ, Martinez-Gonzalez MA, De Irala-Estevez J, et al. Distribution and determinants of sedentary lifestyles in the European Union. *Int J Epidemiol* 2003; 32: 138-46.
2. Mota J, Ribeiro JC, Santos PM, Gomes H. Obesity, physical activity, computer use and TV viewing in Portuguese adolescents. *Pediatr Exerc Sci* 2006; 18: 113-21.
3. Lanningham-Foster L, Jensen TB, Foster RC, et al. Energy Expenditure of sedentary screen time compared with active screen time for children. *Pediatrics* 2006;118: 1831-35.
4. Graves L, Stratton G, Ridgers ND, Cable NT. Comparison of energy expenditure in adolescents when playing new generation and sedentary computer games: Cross sectional study. *BMJ* 2007; 335: 1282-4.
5. Duncan MJ, Staples V. The impact of a school-based active video game play intervention on children's physical activity during recess. *Human Movement* 2010; 11: 95-9.
6. Jordan M, Donne B, Fletcher D. Only lower limb controlled interactive computer gaming enables an effective increase in energy expenditure. *Eur J App Physiol* 2011; 111: 1465-72.
7. Daly A. Can exergaming contribute to improving physical activity and health outcomes in children? *Pediatrics* 2009; 124: 763-71.
8. Graf DL, Pratt LV, Casey N, et al. Playing active video games increases energy expenditure in children. *Pediatrics* 2010; 124: 534-40.

9. Willems MET, Bond TS. Comparison of physiological and metabolic responses to playing Nintendo Wii sports and brisk treadmill walking. *J Hum Kinetics* 2009; 22: 43-9.
10. Graves LEF, Ridgers ND, Williams K, et al. The physiological cost and enjoyment of Wii Fit in adolescents, young adults and older adults. *J Phys Act Health* 2010;7: 393-03.
11. Dishman RK, Motl RW, Saunders R, et al. Enjoyment mediates effects of school-based physical-activity intervention. *Med Sci Sports Exerc* 2005; 37: 478-48.
12. Kolt GS, Driver RP, Gils LC. Why older Australians participate in exercise and sport. *J Aging Phys Act* 2004; 12: 185-98.
13. Graves LE, Ridgers ND, Stratton G. The contribution of upper limb and total body movement to adolescents' energy expenditure whilst playing Nintendo Wii. *Eur J App Physiol* 2008; 104: 617-23.
14. Kendzierski D, DeCarlo KJ. Physical activity enjoyment scale: two validation studies. *J Sport Exerc Psychol* 1991; 13: 50-64.
15. Fruin ML, Walberg-Rankin J. Validity of a multi sensor armband in estimating rest and exercise energy expenditure. *Med Sci Sports Exerc* 2004; 36: 1063-9.
16. St-Onge M, Mignault D, Allison DB, Rabasa-Lhoret R. Evaluation of a portable device to emasure daily energy expenditure in free-living adults. *Am J Clin Nutr* 2007; 85: 742-9.
17. Johannsen DL, Calabro MA, Stewart J, et al. Accuracy of armband monitors for measuring daily energy expenditure in healthy adults. *Med Sci Sports Exerc* 2010; 42: 2134-40.
18. Unnithan VB, Houser W, Fernhall B. Evaluation of the energy cost of playing a dance simulation video game in overweight and non-overweight children and adolescents. *Int J Sports Med* 2006; 27: 804-9.
19. Ainsworth BE, Haskell WL, Whitt MC et al. Compendium of physical activities: an update of activity codes and MET intensities. *Med Sci Sports Exerc* 2000; 32: S498-S516.
20. Murtagh EM, Boreham CA, Murphy MH. Speed and exercise intensity of recreational walkers. *Prev Med* 2002; 35: 397-400.
21. Maddison R, Ni Mhurchu C, Jull A, et al. Energy expended playing video console games: an opportunity to increase children's physical activity? *Pediatr Exerc Sci* 2007; 19: 334-43.
22. Department of Health. *At least five a week: Evidence on the impact of physical activity and its relationship to health. A report from the chief medical office*. London: Department of Health, 2004.
23. Pratchett R. *Gamers in the UK:Digital play, digital life styles.* BBC Audience Research. London: New Media, 2005.
24. Geiwitz PJ. Structure of boredom. *J Pers Soc Psychol* 1996; 3: 592-600.
25. Smith RP. Boredom: a review. *Hum Factors* 1981; 23: 329-40.
26. Sell K, Little T, Taylor J. Energy expenditure during physically interactive video game playing in male college students with different playing experience. *J Am Coll Health* 2008; 56: 505-11.

Accepted: September 15, 2012
Published: September 25, 2012

Address for correspondence:
Dr Michael J. Duncan
Department of Biomolecular and Sports Sciences
Coventry University,
Priory Street
Coventry, CV1 5HB
United Kingdom
e-mail: michael.duncan@coventry.ac.uk

Samantha Dick's: s.dick@coventry.ac.uk