INTERACTIVE DANCE: AN EXCITING WAY TO ENHANCE CHILDREN'S PHYSICAL ACTIVITY LEVEL

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Abstract:

Exergaming has become widely popular as a recreational activity at home and, following that success, new organized group programs are constantly being developed. The problem that emerges is the problem of the adequacy of exercise intensity for participants of different skill and fitness levels. Not many scientific studies investigated the physiological response of the computer-leaded interactive-dance performed in groups. That is why the aim of this study was to determine the physiological load level in children during an "iDance" class ("iDance"; Positive Gaming™). Twenty-one subjects (11 female, 10 male; age 10.7±1.6 years) participated in the study. During the class, heart rate (HR), energy expenditure and the perceived exertion were recorded. The results showed that the mean HR during the class was 147bpm (70.23% of the estimated maximal HR), which indicated that the children exercised at the moderate intensity. Nevertheless, 22% of the overall interactive-dance time was spent in a high-intensity zone. The energy cost values were 5.1 kcal/kg /h. In 86% of participants the activity was perceived as light and they reported being only moderately tired, which was encouraging from the motivational point of view as the measured physiological load was actually higher. In conclusion, we could say that, according to the estimated energy consumption and the exercise intensities recorded, the participation in "iDance" might elicit some positive changes in aerobic capacity. Also, it might be a useful tool in weight management in obese children, but further longitudinal studies are needed to confirm that.

Key words: *exergaming, play, physiological load, caloric consumption, machine-dance*

Introduction

Obesity (as defined by the body mass index of >25) is one of the leading social problems around the world because it significantly increases the risk of various diseases (Lobstein, Baur, & Uauy, 2004; Roberts & Barnard, 2005; Haug, et al., 2009). Also, many studies have identified physical inactivity as one of the main causes of obesity (Patrick, et al., 2004; Must & Tybor, 2005; Roberts & Barnard, 2005; Janssen, et al., 2005; Haug, et al., 2009; Moliner-Urdiales, et al., 2009). Although the need for 60 minutes of moderate to vigorous physical activity per day has been previously identified as required to develop and maintain cardio-respiratory fitness (American Academy of Paediatrics, 2001; Strong, et al., 2005), children in many economically developed countries do not meet that recommendation and spend significantly more time during a day in sedentary activities (Biddle, Marshall, Gorely, Cameron, & Murdey, 2003; Tremblay & Wilms, 2003; Roberts & Barnard, 2005; Bailey, et al. 1995). A rapid development of computer technology and on-line social networks lure children to spend most of their free time in front of various screens. Playing videogames is considered to be one of the particularly risky behaviors associated to obesity (Proctor, et al., 2003; Vandewater, Shim, & Caplovitz, 2004; Maddison, et al., 2011), especially because the food intake is significantly increased while playing videogames in comparison to the standard food consumption during a day (Gore, Foster, DiLillo, Kirk, & Smith West, 2003; Pardee, Norman, Lustig; Preudhomme, & Schwimmer, 2007; Chaput, et al., 2011). Furthermore, the food consumed while playing videogames usually contains a high portion of fat and sugars (Coon, Goldberg, Rogers, & Tucker, 2001). The increase in habitual physical activity is undoubtedly one of the basic approaches for the improvement of body composition in children and youth (DeMattia, Lemont, & Meurer, 2007; Maddison, et al., 2011). Being aware of that, some manufacturers have developed active videogames with motion-sensitive consoles. These games are based on the performance of authentic movements of various sports and physical activities. The idea of this new technology is to promote physical activity among the videogame players. Indeed, energy expenditure research has reported that active videogames playing is comparable to medium intensity exercise (Daley, 2009) and positively associated with the oxygen uptake increase (Dixon, et al., 2010). Also, in comparison to inactivity and playing passive videogames, a significantly higher level of cardiovascular activity and energy expenditure while playing active videogames has been systematically reported (Graves, Stratton, Ridgers, & Cable, 2007; Mellecker & McManus, 2008; Graf, Pratt, Hester, & Short, 2009; Foley & Madison, 2010; Graves, et al., 2010). However, general knowledge about the longterm efficiency of exergaming on physical fitness is still limited; some studies even suggested that active videogames were not appropriate replacement for games and participation in authentic outdoor activities (Graves, et al., 2007, 2010). Most of the published studies dealt with the self-administrated exergaming, meaning that children were exercising alone at home; therefore, there is a lack of studies researching physical load and energy expenditure during organized and lead group classes. The problem arising with the development of group programs is an issue of adjusting performance intensity of the game for the participants of different skill and physical fitness levels. We hypothesized that whatever the intensity may be, it might be too low for some children while at the same time being too high for the others. That is why the aim of this study was to determine the physiological load and energy expenditure during a "iDance" class as well as overall satisfaction and perceived physical exertion during that type of physical activity. Also, we were interested whether that elicited physiological response was related to the dancing proficiency of the subjects, meaning the experience with "iDance", and the playing level, as well as with the engagement in other sporting activities.

Methods

Subject sample

The sample consisted of 21 subjects (11 female, 10 male; age 10.7±1.6; range 6.0-13yrs), regular attendees of the "iDance" program at the *Dance club "Mrak korak" Zagreb*. The subjects were on average 150.1±9.2 cm tall, their average body mass was 45.4±11.2 kg and they had one to seventeen months of "iDance" experience. The inclusion criteria were the written consent of subjects' parents and previous training participation of at least one month, two times a week. For the purpose of data analysis, the subject were also divided into two groups: in one were the subjects participating in other organized sporting activities apart from the "iDance" classes, and in the other those who only practiced "iDance" twice a week. The rationale for such a division was the fact that this program claimed to have the advantage of adjusting the game level for the participants of different skill and fitness background so the testing of the differences between otherwise active and inactive children was a way to verify the manufacturer claim.

Procedures

The subjects were tested during one Machine "iDance" class (Figure 1). The "Machine iDance" is a computer game played by the body movements under the visual instructions, provided by a special software and displayed on the big screen in front of the participants. During the game the players stand on the dance platform and place their feet, and sometimes hands, on touch-sensitive areas according to the directions defined by the arrows showed on the screen. The "iDance" platform registers players' movements and provides the feedback on timing and accuracy of the steps performed. A wide range of music and the possibility to select from 25 game levels provide different exercise intensity levels. The feedback on success of a single dance (song) is represented by the percentage of accuracy in both accuracy of movement and accuracy of timing in comparison to the possible maximal score. An "iDance" session lasts 60 minutes and includes three different parts. *The introductory part* lasts 5 minutes and contains dynamic stretching exercises. The *main (central) part* takes 50 minutes and includes the software lead dance. The level of the dance game increases in every following song if the subject accomplishes 80% of the possible maximal score of the previous song. The most interesting fact in this program is the possibility of the software to produce the instructions for several levels of the game at the same time and on the same screen. That is how it has been provided that the intensity levels at which the participants are dancing need not be the same for all of them, even though they are dancing to the same music. The higher levels require more foot and hand touches of the floor platform in a second than the lower levels in one minute. During the last 15 minutes of the main part, the competition

Figure 1. Interactive dancing session

goes on. In the *ending part*, the static stretching and breathing exercises are performed.

Variables

The sample of variables measured during the class encompassed heart rate (HR), monitored using the heart rate monitor (Cardiosport Ultima PC) and accompanying software (Cardiosport Heart Trainer Pro) that enables subsequent estimation of energy expenditure in kcal. The mean (HRmean) and the peak (HRpeak) heart rates were then expressed as a percentage of the individual HRmax to determine individual exercise intensity for each subject. The subjective assessment of the implemented program was examined using a written feedback form. The questionnaire consisted of the multiple-choice questions regarding children's satisfaction and their perceived physical exertion.

Statistical analysis

The obtained data were processed by the software package Statistica for Windows ver. 10.0, licensed to the University of Zagreb (StatSoft, Tulsa, USA). The basic descriptive parameters of the observed variables and the normality of the curve parameters were calculated. The normality of the distribution was tested by the Kolmogorov-Smirnov test. The differences between the groups in HR and energy expenditure were tested using the Student's *t-test for independent samples* and the Mann Whitney U test. The relation between the variables was established with correlation analysis and expressed by the Spearman correlation coefficient. The non-parametric Spearman rank correlation was used because some variables were not normally distributed. The level of statistical significance was set at $p<.05$.

Results

As the data were recorded during the "iDance" class for each subject, the mean HRs, the maximal HRs and the peak HRs were extracted or calculated from the heart rate monitor software. In Figure 2 the average mean and the average peak HRs during the class are presented as the percentages of the calculated individual maximal heart rates.

The heart rate and energy expenditure values obtained in the "iDance" training session are presented in Table 1. The heart rate values are presented as a percentage of maximal HR (HRmax), which was determined before testing as 220-age, whereas the caloric costs are presented in absolute values and also relative to the child's weight.

The correlations between experience in interactive dancing (participation time), success (the mean playing level reached), exercise intensity (mean HR as the percentage of the HRmax) and energy expenditure (the mean caloric costs per kilogram of body mass) are presented in Table 2. The non-parametric Spearman rank correlation was used because some variables were not normally distributed.

The expected positive correla-tions were found between the experience and game level as well as between the exercise intensity, expressed in

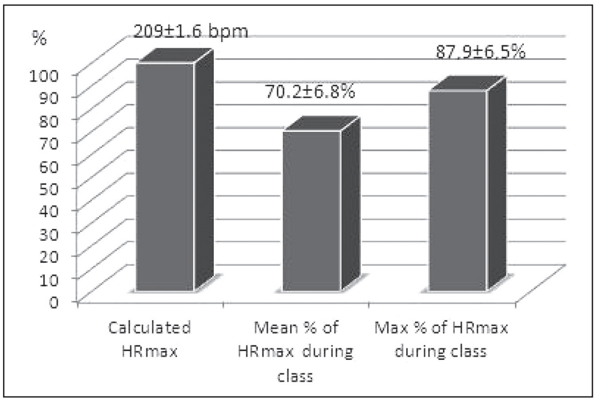

Figure 2. The average HRmean and HRpeak recorded during the class and expressed as the percentages of the average estimated maximal HR of the subjects.

Table 1. The heart rate values (expressed as the % HRmax) and the caloric consumption during the "iDance" training session

	Mean±SD	Minimum	Maximum
HRmean (as % of HRmax)	70.2±6.8	58.5	84.9
HRpeak (as % of HRmax)	88.0±6.5	73.4	100.0
Mean estimated energy consumption (kcal/h)	229.0±95.2	101.0	518.0
Mean estimated energy consumption (kcal/kg/h)	5.1±1.1	3.0	7.9

Table 2. Rank correlation coefficient (Spearman R) between the HRmean, energy expenditure, experience and playing level

	HRmean	Energy expenditure	"iDance" experience	Game level
HRmean %HRmax)	1.00	0.66*	-0.27	-0.31
Energy expenditure	0.66*	1.00	-0.41	-0.28
"iDance" experience	-0.27	-0.41	1.00	0.70*
Game level	-0.31	-0.28	0.70*	1.00

Note: * The correlation is significant at the level of p<.05.

Table 3. The differences in intensity (HRmean as %HRmax) and energy expenditure (kcal/kg) among children that participate in other sporting activities (Yes other sport) and children who do not participate in other sports (No other sport)

	Mean±SD		p
	No other sport (n=12)	Yes other sport (n=9)	
HRmean (as %HRmax)	71.15±5.68	68.72±8.44	0.256
kcal/kg per hour	5.31±1.24	4.76±0.93	0.293

Table 4. The perceived exertion and the satisfaction with the "iDance" program in percentages

Physical demands of "iDance" training	**%**
It is not hard at all.	19
I am a little tired.	67
I feel it hard, but there is no problem to follow the steps.	14
I feel it hard and difficult to follow the steps at higher levels.	0
I feel it very hard and sometimes I have to stop the game.	0
Satisfaction with the program	**%**
I am very satisfied and want to continue doing it.	95
I am satisfied, but I prefer to change activity for the next year.	5
I do not like it. I go because I have to.	0

%HRmax and energy expenditure. However, no correlations were determined between the "iDance" experience or game level and physiological load (mean HR and estimated energy consumption). That was an important finding as it confirmed that the achieved game levels could be adjusted to elicit adequate physiological response for both the skilled and non-skilled players. The results of the Mann Whitney U test for independent samples did not prove any significant difference in HRmean expressed as the percentage of HRmax, while the Student *t*-test for independent samples did not find any differences in energy expenditure between the groups of children that participated and did not participate in other sporting activities (Table 3).

Table 4 shows the children's subjective assessment of the interactive dancing program, meaning their perceived exertion during the class and their overall satisfaction with the program.

Discussion and conclusions

The main findings of this study are that the "iDance" program elicits similar physiological responses in all children, no matter what their skill level was, proficiency or other engagement in sporting activities. The average HRs during the class varied from 120 to 150 bpm, or 60-75 % if expressed as percentage of maximal heart rate. The average value of the mean HRs during the class was 147 bpm, or 70.23±6.8% of the estimated HRmax, which implied that the largest portion of the training session the children exercised at the moderate aerobic intensity level. Therefore, the mean exercise intensity of the "iDance" training was between the extensive (fat burn) and intensive aerobic zone (cardiovascular workout) where the body burns carbohydrates and fat to sustain muscular work. The recorded exercise intensity meets the recommendations of the American College of Sports Medicine (ACSM) for improving the cardio-respiratory fitness (American Academy of Paediatrics, 2001; Daley, 2009). Similar findings, meaning that the dance simulation game led to the cardio-respiratory response comparable to medium intensity aerobic dance dance, were offered in the study dealing with cardio-respiratory responses while playing active dance videogame (Tan, Aziz, Chua, & Teh, 2002).

The main difference between the "iDance" and the other studied exergaming was that the latter was led by an expert and was not self-administrated, which did not allow the children to stop the activity at their own will, as it happened at home. According to Ridley and Olds (2001), children will engage in vigorous bouts of activity during short-duration active gaming. Also, the same study recorded that when offered a diversity of gaming modes in a videogame center setting, children spent only half of their time playing active games followed by periods of lower-intensity walking. It seems that children when gaming maintain the intermittent style of play (Ridley & Olds, 2001). In comparison to the above-mentioned studies and with regard to the time spent in specific intensity zones, it seems that "iDance" program offered a larger portion of overall time spent in higher intensity (11 out of 50 minutes, or 22% of overall 'iDance' time) than the self-administrated playing of video games. The HRpeaks, which were on average of 87.95 % of the HRmax, suggest that in many dancers the anaerobic threshold was reached so we could presume that at least one part of the "iDance" session induced anaerobic response.

There was no correlation between the mean HR and the estimated energy consumption with the "iDance" experience. The experience did not influence physiological response as the program offered the possibility for the more experienced children to exercise at higher game levels. This is important for maintaining high physiological loads despite a longer participation and high dance proficiency. That enables the adjustments (individualization) of training intensity within one class, which is usually not possible in standard aerobic group programs in health clubs. This might be particularly interesting for the obese children and the children with some functional and/or coordination problems who are reluctant to participate in the other team sports (Daley, 2009). Namely, the possibility to play in a group and be a part of a team, despite the adjusted playing level, is very motivating.

In comparison to the energy expenditure levels during the classic sedentary gaming or while playing some of popular active video games, the observed mean caloric expenditure was significantly higher during interactive dancing. Energy costs of 5.1 kcal/ kg in an hour or 229 kcal/h determined by the present study is significantly higher than the values recorded while playing attractive Wii Sports Tennis and Wii Sports Boxing at the gaming console Nintendo Wii (Nintendo, Redmond, WA), which was 179.1 kcal/h and 174.4 kcal/h, respectively (Graves, et al., 2010). For example, caloric consumption during the medium intensity basketball playing in children of similar body weight would amount approximately 259.1 kcal/h (Crouter, Clowers, & Bassett, 2006; Moy, Scragg, McLean, & Carr, 2006), while tennis playing at the same intensity would costs nearly 331.4 kcal/h or 5.5 kcal/min (Edholm, Humphrey, Lourie, Tredre, & Brotherhood, 1973; Jing & Wenyu, 1991; Crouter, et al., 2006; Kozey, Lyden, Howe, Staudenmayer, & Freedson, 2010). Depending on the standard level, one hour of soccer playing would tax a child between 317.8 or 5.3 kcal/min and 454.0 kcal or 7.6 kcal/min (Taylor, et al., 1978; Ferrauti, Giesen, Merheim, & Weber, 2006), whereas the same amount of volleyball time burns between 136.2 or 2.3 kcal/min and 272.4 or 4.5 kcal/min (Taylor, et al., 1978; Moy, et al., 2006).

We also wanted to determine whether the children who were engaged in other sporting activities could also benefit from this program or whether it would be too light for them. The children who do not participate in other sports might be spending more calories per body weight than the children participating in other sports, but it did not prove to be statistically significant. That was obtained by the adjustments of the "iDance" software so the athletic children followed the part of the screen modified to induce appropriate/wanted physiological responses, but that has to be confirmed with a larger sample.

As subjective perception of the exergaming may have implications for the long-term viability (Chin, et al., 2008), we aimed to gain insight into the children's level of satisfaction with the "iDance" program. As in this study 95% of the children were very satisfied with the program and majority of them perceived an interactive dancing as light despite its actual moderate to high loads, we might assume that "iDance" would keep their interest longer that the standard home games. Usually, children initiate and sustain video game playing because it is fun, exciting, and challenging (Griffiths & Hunt, 1998; Mellecker & McManus, 2008). When they reach a high level of proficiency, children lose their interest for gaming (Daley, 2009), the regular use decline and the rate of dropouts increase over time (Madsen, Yen, Wlasluk, Newman, & Lustig, 2007).

In conclusion, although "iDance" has no power to substitute for all of the children's needed activity, it seems that it might produce even better effects on children's physical fitness and body composition than the similar self-administrated active video games. According to the estimated energy consumption and the exercise intensities recorded, the participation in "iDance" program might elicit some positive changes in capacity. Also, it might be an useful tool in weight management of obese children, but further longitudinal studies may be needed to confirm that. As the dancing program requires high coordination and agility as well as anticipation skills, it might also be a useful tool and a complimentary conditioning activity in young athletes, for example, in tennis players. Furthermore, this study showed that this program enabled every participant to exercise at the similar exercise intensity regardless of their experience or participation in other sports because game levels were very adjustable. Despite of the recorded exercise intensities between the extensive and intensive aerobic zone and sometimes even anaerobic zone, the children perceived the interactive dancing program as a light effort exercise, probably because they had fun, which is the most important characteristic of any activity for children at that age.

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INTERAKTIVNI PLES: UZBUDLJIV NAČIN ZA POVEĆANJE TJELESNE AKTIVNOSTI

„Exergaming“ odnosno tjelesna aktivnost u računalom vođenim igrama postala je široko popularna rekreacijska aktivnost i neprestano se razvijaju novi programi. No, javlja se problem primjerenosti intenziteta vježbanja za sudionike različitih razina vještina i tjelesnih sposobnosti. Nema mnogo istraživanja koja su proučavala fiziološki odgovor na računalno upravljani interaktivni ples koji se izvodi kao grupni program. Cilj ovog istraživanja bio je utvrditi razinu fiziološkog opterećenja u djece tijekom sata "iDance" ("iDance"; Positive Gaming™). Dvadeset i jedan ispitanik (11 djevojčica, 10 dječaka u dobi od 10,7±1,6 godina) je sudjelovao u istraživanju. Tijekom sata su mjereni frekvencija srca, kalorijska potrošnja (procjenom) te subjektivni osjećaj opterećenja. Rezultati su pokazali da je prosječna frekvencija srca vježbača tijekom sata bila 147/min (70,23% od procijenjene maksimalne frekvencije srca) što pokazuje da su djeca vježbala umjerenim intenzitetom. Ipak, čak 22% ukupnog vremena interaktivnog plesa pleasči su proveli u zoni visokog intenziteta. Procijenjena kalorijska potrošnja je iznosila 5,1 kcal /kg /h. Unatoč tome, čak 86% sudionika doživjelo je aktivnost kao laganu i zabavnu i subjektivno su osjećali samo umjereni umor. To je ohrabrujuće u motivacijskom smislu jer su izmjerena fiziološka opterećenja zapravo bila viša. U zaključku, možemo reći da bi, prema procijenjenoj kalorijskoj energetskoj potrošnji i intenzitetu aktivnosti, sudjelovanje u "iDance" programima moglo imati pozitivno utjecati na promjene u aerobnim sposobnostima. Također, to bi moglo biti korisno oruđe u reguliranju tjelesne mase u pretile djece, ali bi bilo potrebno provesti longitudinalno istraživanje za donošenje konačnog zaključka.

Ključne riječi: *računalne igre, fiziološko opterećenje, kalorijska potrošnja, interaktivni ples*