Pediatric Exercise Science, 2007, *19*, 334-343

Energy Expended Playing Video Console Games: An Opportunity to Increase Children's Physical Activity?

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This study sought to quantify the energy expenditure and physical activity associated with playing the "new generation" active and nonactive console-based video games in 21 children ages 10–14 years. Energy expenditure (kcal) derived from oxygen consumption (VO_2) was continuously assessed while children played nonactive and active console video games. Physical activity was assessed continuously using the Actigraph accelerometer. Significant (p < .001) increases from baseline were found for energy expenditure (129–400%), heart rate (43–84%), and activity counts (122–1,288 versus 0–23) when playing the active console video games. Playing active console video games over short periods of time is similar in intensity to light to moderate traditional physical activities such as walking, skipping, and jogging.

Regular physical activity is necessary for health and to maintain a healthy body weight. U.S. physical activity data (1) suggest that approximately 70% of children ages 9–13 years report participating in free-time physical activity, and only 40% reported participating in any organized physical activity. For high school students, only 36% had participated in at least 60 min per day of physical activity on 5 or more of the 7 days preceding the survey. These findings mirror patterns in the United Kingdom, where 70% of boys and 61% of girls participated in 60 min/day of physical activity on 7 days a week outside of school hours (25,29). These data suggest that there are still considerable numbers (30–40%) of young people, in particular adolescent girls, who do not participate in sufficient levels of physical activity (14).

Current lifestyles and environments might discourage regular physical activity and encourage sedentary behaviors in children. Active transport, particularly to and from school, has decreased over recent years. Over the past 15 years, the proportion of 5- to 16-year-olds walking to school in the United Kingdom has fallen to 49%, while those traveling to school by car increased to 28% (6).

Time children spend watching television, playing electronic games, and using computers has been associated with an increased risk of obesity (9,11,23,35). These

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are key sedentary behaviors among young people, taking up to 3 hr and 45 min each day, with a peak between the ages of 9 and 12 (5).

Video game playing is pervasive. Annual 2004 U.S. sales of video games (including portable and console hardware, software, and accessories) exceeded $9.9 billion and were similar to the 2003 sales of $10 billion (20). A U.S. survey reported that children in Grades 7 and 8 spent an average of 4.2 hr/week playing video games (7). In the United Kingdom, one hundred percent of the 3.7 million 6- to 10- and 97% of the 3.7 million 11- to 15-year-olds played some form of electronic game. Ninety-one percent of children played three or more platforms, with video console games being the preferred choice. For 11- to 16-year-old children, 74% played 3–7 times per week (average session 1.9 hr). Similar results have also been reported for 6- to 10-year-olds (21). This electronic game use mirrors that seen in other countries (1).

A new generation of active video console games ("exer-gaming") such as Sony EyeToy and Dance Simulation products (e.g., Dance Dance Revolution [DDR] or Dance UK) might provide a novel opportunity to turn a traditionally sedentary behavior into a physically active one. EyeToy games use a USB camera, which is placed on top of the television, to put the players onscreen in the center of the games. Players then physically interact with images onscreen in sport-based activities such as football, boxing, dancing, or kung fu. The game depends on player movement in front of the camera for both control and actual gaming (Figure 1). Home-based

Figure 1 — Example of EyeToy Knockout game play (example of the image that the user would view when playing the EyeToy PlayStation 2 boxing simulation game). Printed with permission from Sony Computer Entertainment Europe.

dance pads have also been adapted from arcade games (DDR) for use in gaming consoles such as PlayStation 2 and Xbox. Participants stand on the dance pad that is connected to a console and respond by stepping on a corresponding series of arrows and symbols that scroll up on the screen in time to fast music.

Previous studies have reported the energy expenditure associated with playing the arcade-style, (22,24,30) home-based dance simulation games (33) and nonactive video console games (36). Of these, one (30) found that the exercise intensity of playing reached the minimum ACSM criteria for developing and maintaining cardiovascular fitness in adults (70% HR_{max} and 53% heart-rate reserve), whereas the second study (33) reported that the minimum standard was achieved for heart rate but not for VO_2. To the best of our knowledge, the energy expenditure associated with playing EyeToy games has not yet been quantified, hence this is the main focus of this study. Specifically, we aimed to quantify the energy expenditure and activity levels associated with playing home console and the new generation exer-gaming video games in order to determine if active games have potential as an appealing strategy to increase physical activity in children.

Methods

Participants

Children were eligible if they met the following criteria: between the ages of 10 and 14 years, owned a PlayStation 2 console with EyeToy games, were English speaking, and were able to provide informed assent and parental consent. Children who were unable to perform physical activity for medical reasons were excluded. Participants were recruited via community advertisements, direct contact with local schools, and word of mouth. Ethical approval was obtained from the Northern Regional Ethics Committee before the start of the study.

Procedures

All assessment procedures were performed in a temperature-controlled laboratory setting at the University of Auckland. Following a verbal explanation of the study procedures, height (Harpenden Stadiometer, Chasmors Ltd, London) and weight (Salter scales) were measured according to a standardized protocol (19). Although all participants self-reported some previous experience (novice level) playing active electronic video games, a familiarization period of 20 min was permitted, allowing each participant the opportunity to play with any of the study games that they were less familiar with. During this time children were able to practice with the various EyeToy and dance simulation games. After 20 min, participants were asked to discontinue play and rest for 5 min before being fitted with a Polar Accurex heart-rate monitor (Kempele Finland) and a Manufacturing Technology, Inc. (MTI) Actigraph Accelerometer (Model AM7164-2.2C). Both methods have been shown to be reliable and valid measures in children and adolescents (22,31,32). The Polar heart-rate transmitter band was secured to each participant's chest (just below nipple height) using an elastic strap. Heart-rate data were recorded continuously at 1-s intervals. The accelerometer is small (5.1 × 3.8 × 1.5 cm) and light weight (43g) and measures motion in the vertical plane, with movement outside of normal motion being filtered electronically. Children wore the accelerometer above their right hip at the midaxilla line. Previous literature on children and youth have found that the Actigraph hip placement is superior to other placements (15,18). Oxygen uptake during rest and the video-game conditions were measured using the MetaMax3B (Cortex, Biophysik) portable indirect calorimetry gas-exchange analysis system, a device with demonstrated precision (12,16). Portable indirect calorimetry is an appropriate and reliable approach to assess energy expenditure of children and adolescents (8,32). The MetaMax3B allows the participant to perform physical activities unrestricted. A face mask (Hans Rudolf, Kansas City, MO) that was held in place by a nylon harness covered the participant's nose and mouth. The mask was attached to a bidirectional digital turbine flow meter to measure the volume of inspired and expired air. A sample line connected between the turbine and analyzer unit determined O_2 and CO_2 content. A two-point calibration procedure was conducted before each testing session according to the manufacturer's guidelines (Cortex Biophysik MetaMax3B manual). Calibration of the oxygen and carbon dioxide sensors was performed with standard gases of known concentrations (O_2 15% and CO_2 5%). Respiratory volume was calibrated using a 3-L volume syringe. Ambient air measurement was also conducted before each test.

Active Video Games

Each participant was measured at seven time points: resting (seated), inactive video game (seated), and playing each of the following active electronic games: EyeToy Knockout (boxing), Homerun (baseball), Groove (dancing upper body), AntiGrav (hover-board), and PlayStation 2 Dance UK (dance pad). The order of allocation for active video games was randomized for each participant (using a Latin square) to reduce the effect of game ordering or fatigue. These games were chosen to represent a broad spectrum of energy expenditure.

EyeToy Homerun is a baseball-simulation game in which the users stand in front of the screen and respond to a digital character that throws a variety of pitches. The children respond by swinging their arms in a batting motion to hit each ball. To move their character to a base or to achieve a home run, the child must run or jump on the spot while simultaneously waving their arms. EyeToy Knockout is a boxing simulation in which the user competes by shadow boxing against a variety of digital opponents. The children punch the opponent to score points while evading their opponent's punches (see Figure 1). EyeToy AntiGrav is a hoverboard game in which the users move their heads, arms, and bodies to direct a digital character around a virtual reality course. Additional points are earned by performing a number of tricks (jumps, slides, and loops) that are controlled by the users waving their arms and moving their bodies. EyeToy Groove is a dance game in which users move their body and arms to reach for and touch a variety of moving targets in time with a musical sound track. PlayStation 2 Dance UK is a dance mat simulation game, described previously. To standardize game play, the following steps were taken: (a) for EyeToy Knockout and Homerun, all participants started at the easiest level (Level 1) and progressed through increasing levels of difficulty at their own pace (all participants achieved Level 3, but none exceeded Level 4); (b) for EyeToy Antigrav, an identical game scenario was chosen for all participants and was reset if children completed the game in 5 min; (c) for EyeToy Groove and Dance UK, the same routine was chosen for all children. Consistent with previous research (22), participants were measured for a minimum of 5 min (maximum of 8) in each condition. This time period was chosen to provide sufficient time for children to achieve a steady state.[1] A brief rest period of 3–5 min took place between each game to allow heart rate and VO_2 to return to normal levels. Gas-exchange variables (oxygen uptake [VO_2], minute ventilation, and respiratory exchange ratio) were measured using the MetaMax3B. Breath-by-breath measurement was recorded using the MetaSoft software (version 3.4, Statera edition). Heart rate and activity counts were both recorded continuously.

Data Analysis

Heart rate, VO_2, minute ventilation, and respiratory exchange ratio were monitored continuously, and the mean readings during the final minutes of game playing were taken as the steady state for each variable.

Mean VO_2 was converted into units of energy expenditure (kcal/min) using the constant 1 L O_2 = 4.9 kcal (mixed diet) (13). Child-specific metabolic equivalent values (METs) were also calculated by dividing the oxygen consumption (VO_2) of the respective activities by the resting values. Activity counts were expressed as counts/min over the entire game period.[2] As each participant was measured repeatedly over each condition, repeated measurement mixed-model analysis was conducted to compare the mean values of energy expenditure across conditions with Tukey multiple post hoc comparisons. All analyses were performed using SAS (Statistical Analysis Systems) version 9.1.3.

Results

Twenty-one children (11 males and 10 females), ages 10–14 years (12.4 ± 1.1) participated in the study (Table 1). Mean body-mass index was 20.3 (± 4.0) kg/m^2. Mean VO_2 during active games ranged from 11.19 ± 2.2 to 24.48 ± 4.9 ml · kg^{-1} · min^{-1} (Table 2).

Energy expenditure was significantly ($p < .001$) greater in the active video games (range = 2.9 ± 0.7 kcal/min to 6.5 ± 1.7 kcal/min or 2.9 ± 0.6 to 5.0 ± 0.8 METs), compared with rest (1.3 ± 0.2 kcal/min or 1.0 MET) and nonactive gaming (1.6 ± 0.2 kcal/min or 1.3 ± 0.2 METs) conditions (Table 2). The highest energy expenditure was seen in the boxing game Knockout, (6.5 kcal/min or 5 METs) and the baseball game Homerun (6.0 kcal/min or 4.8 METs). Active video games resulted in significantly greater heart rate and activity counts compared with the nonactive and resting condition ($p < .001$). No sex differences were found for all measurements (kcal, METs, heart rate, and activity counts) under any of the game playing conditions ($p > .1$).

Table 1 Baseline Characteristics by Gender (*M* ± *SD*)

Participant	Age (year)	Height (cm)	Weight (kg)	BMI (kg/m^2)	WC (cm)
Females	12.2 ± 1.0	158.5 ± 5.0	48.8 ± 11.0	19.3 ± 4.0	67.1 ± 10.0
Males	12.6 ± 1.1	164.8 ± 13.2	58.2 ± 15.6	21.2 ± 4.0	74.6 ± 11.3
Total	12.4 ± 1.1	161.8 ± 10.4	53.7 ± 14.2	20.3 ± 4.0	71.0 ± 11.1

Note. BMI = body-mass index; WC = waist circumference.

Table 2 VO_2, Energy Expenditure, Heart Rate, Activity Counts, and METS for Each Condition (*M* ± *SD*)

Condition	VO_2 ml · kg^{-1} · min^{-1}	Increase from rest (%)	EE kcal/min	HR beats/min	AC counts/min	METs
Rest	4.9 ± 0.9	0	1.3 ± 0.2	78 ± 13	0.2 ± 0.9	1.0 ± 0.2
Nonactive	6.6 ± 1.6	74	1.6 ± 0.2	82 ± 14	23.2 ± 28.6	1.3 ± 0.2
Knockout	24.5 ± 4.9	403	6.5 ± 1.7	142 ± 16	1,217.5 ± 640.4	5.0 ± 0.8
Homerun	23.0 ± 4.0	376	5.9 ± 1.8	138 ± 18	2,132 ± 1446.7	4.8 ± 0.9
Dance UK	18.9 ± 3.6	292	4.9 ± 1.3	127 ± 13	1,288.1 ± 619.4	3.9 ± 0.8
Groove	11.2 ± 2.2	129	2.9 ± 0.3	111 ± 12	122.9 ± 110.4	2.3 ± 0.3
AntiGrav	14.0 ± 3.8	186	3.6 ± 1.1	110 ± 13	1,058.7 ± 506.6	2.9 ± 0.6

Note. VO_2 = volume of expired oxygen (oxygen consumption); EE = energy expenditure; HR = heart rate; AC = activity counts (actigraph accelerometer); METs = metabolic equivalent.

Discussion

We found that playing new generation active electronic games resulted in moderate to high energy expenditure in children. The energy expenditure is of similar magnitude to other physical activities such as brisk walking, skipping, jogging, and stair climbing (8,27). Our findings are consistent with those of studies that have measured energy expenditure of playing new generation video arcade games (22) and dance simulation games (30,33). The games used in this study, however, are part of the PlayStation 2 library and, therefore, can be played in the home alone or with others.

A key strength of this article is that it is the first to document the energy expended associated with playing the new generation EyeToy exer-gaming active video games. Moreover, this study used portable VO_2 measurements, allowing the children to play the games in an unrestricted and more ecological environment. Although not all games from the EyeToy range were able to be examined, the choice of games used in the present study represents a continuum of the activity ranges for active video games.

There are some possible negative aspects of active gaming that should be considered. It is possible that there might be ethnic or socioeconomic disparities in ownership or use of this technology in some countries (games cost approximately $20–50), although this is not the case in New Zealand, where Maori and Pacific households have similar or greater ownership rates of electronic gaming devices than non-Maori, non-Pacific households (1). We only collected energy expenditure data on children who rated themselves as novice active video game players. The energy cost of these games might differ between novice and expert players, which might be related to economy of movement or the difficulty associated with the higher levels of game play. Future studies might consider these issues and also provide a longer period of habituation.

Differences in energy expenditure were found between the various active video games, with those requiring whole body movement (Homerun and Knockout) resulting in greater energy expenditure (kcal) and body movement, or activity counts, compared with games only requiring upper-body movement. Physical activity intensities are categorized in absolute terms as light (< 3 METs), moderate (3–6

METs), or vigorous (> 6 METs) (3). According to this classification, two of the games (AntiGrav and Groove) would be classified as light intensity physical activity, with the remaining active games (Dance UK, Homerun, Knockout) equivalent to moderate-intensity physical activity. Future studies might compare the energy expenditure of upper-body exercise (arm cranking) with video games that primarily use upper-body movement (e.g., EyeToy Groove).

In the present study, MET values were derived by dividing VO_2 of the activities by VO_2 at rest. METs represent the energy cost of physical activities as multiples of the resting metabolic rate. One MET is defined as the energy expended while resting quietly, which equates to ~3.5 ml of oxygen/kg body weight/min or 4.186 kJ/kg body weight/hr for adults (2). Estimation of MET values for children have been (22) derived using the adult definition of 1 MET (27). This approach has been criticized because of reported differences in the energy cost of nonsedentary physical activities between children and adults. Applying adult MET values to our data resulted in an overestimation of active video game METs (range = 3.2–7.0) compared with using child-specific MET (range 2.3–5.0). These results have implications for the interpretation of studies that report the energy cost of physical activities in child populations. More data are required on the energy cost of various physical activities in children.

These data suggest that substituting periods of inactivity (nonactive video game playing) with sustained active video game play (e.g., 30-min period per day) could have a measurable impact on body weight. Given that 1 MET is equivalent to rest, the net gain of playing the more active video games would be 4 METs. One kilogram of body fat contains the equivalent of 30,000 kJ of energy (with water and protein considered). Therefore, based on an estimated energy expenditure excess of approximately 655 kJ/30 min game playing (3275 kJ/5 days), a child could lose 1 kg body fat in approximately 9 weeks, if all other factors (e.g., diet) remained constant.

The current recommendation for physical activity for children is to perform 60 min of moderate to vigorous activity on most days of the week (4,34). These recommendations are still not being met by a substantial proportion (30–50%) of international populations (10,25,26,29). Alternative approaches such as active video games could go some way to increasing daily physical activity. Furthermore, these games have the potential for spill over effects for other forms of physical activity. For children who are inactive, increased interest in being more active might be mediated by increased enjoyment, a well documented barrier to regular physical activity for children and adolescents (17,28).

Despite the potential for active video games as a way to increase physical activity, sustainability of this activity for children is yet to be determined. This study examined the energy expenditure associated with playing active video games during discrete bouts of activity (5 min). Furthermore, research is needed to determine whether children would play these games frequently enough and for long enough to have a measurable impact on their health and fitness.

Playing active video games is associated with increased energy expenditure in children similar in intensity to light to moderate traditional physical activities. These games have the potential to contribute to increases in daily physical activity for children, particularly among those who are most sedentary.

Notes

1. Although the EyeToy and Dance Mat games are incremental in nature (intensity), these increments are not standardized as typically used during a VO_2 maximal test. Children progress through each game stage based on their respective skill level. Therefore, true steady physiological state is difficult to assess. A pragmatic approach was adopted in this study so that the investigators were able to visually observe leveling off of the physiological parameters (VO_2 and heart rate) using the MetaSoft software display. When this occurred, the mean readings of the final minutes of game playing were taken as the steady state for each variable.

2. In the present study, activity counts were expressed as counts/min over the entire game period. This approach is consistent with the methodology adopted by Ridley and Olds (22) and assists with comparison across these two studies. It is also important to acknowledge, however, that this approach included the collection of steady- and nonsteady-state data, and most likely underestimated activity counts.

Acknowledgments

This study was supported by a grant from the Health Research Council of New Zealand. Sony Computer Entertainment New Zealand provided the gaming software for the study.

References

1. AC Nielsen. *National Readership Survey and Panorama*. Auckland, New Zealand, 2005.
2. Ainsworth, B.E., W.L. Haskell, A.S. Leon, et al. Compendium of physical activities: classification of energy costs of human physical activities. *Med. Sci. Sports Exerc.* 25:71-80, 1993.
3. Ainsworth, B.E., H.J. Montoye, and A.S. Leon. Methods of assessing physical activity during leisure and work. In: *Measuring Physical Activity and Energy Expenditure*, H.J. Montoye, H.C.G. Kemper, W.H.M. Saris, and R.A. Washburn (Eds.). Champaign, IL: Human Kinetics, 1996, pp. 146-159.
4. Australian Government Department of Health and Ageing. *Australia's Physical Activity Recommendations for Children and Young People.* Available at: www.health.gov.au/internet/wcms/publishing.nsf/Content/health-pubhlth-strateg-active-recommend.htm. Accessed December 9, 2005.
5. Biddle, S., S. Marshall, T. Gorely, N. Cameron, and I. Murdey. *Project S.T.I.L. (Sedentary Teenagers and Inactive Lifestyles) Systematic Literature Reviews Executive Summary*. Loughborough: Loughborough University, 2003.
6. Department for Transport. *Travel to School in GB. Personal Travel. Factsheet 2*. London: Department for Transport, 2003.
7. Dorman, S. Video and computer games: Effect on children and implications for health education. *J. Sch. Health*. 67:133-138, 1997.
8. Harrell, J.S., R.G. McMurray, C.D. Baggett, et al. Energy costs of physical activities in children and adolescents. *Med. Sci. Sports Exerc*. 37:329-336, 2005.
9. Jackson, R.J. Commentary on active living research. *Am. J. Prev. Med*. 28:218-219, 2005.
10. Janz, J.K., J.C. Golden, J.R. Hansen, and L.T. Mahoney. Heart rate monitoring of physical activity in children and adolescents: the Muscatine study. *Pediatrics*. 89:256-261, 1992.

11. Janz, K.F., S. Levy, T.L. Burns, et al. Fatness, physical activity, and television viewing in children during the adiposity rebound period: the Iowa Bone Development Study. *Prev Med*. 35:563-571, 2002.
12. Larsson, P.U., K.M. Wadell, E.J. Jakobsson, L.U. Burlin, and K.B. Henriksson-Larsen. Validation of the MetaMax II portable metabolic measurement system. *Int. J. Sports Med*. 24:115-123, 2004.
13. McArdle, W.D., F.I. Katch, and V.L. Katch. *Exercise Physiology: Energy, Nutrition, and Human Performance*. Philadelphia: Lea & Febiger, 1991.
14. McGeorge, S. *Couch Kids: The Continuing Epidemic*. London: British Heart Foundation, 2004.
15. McIver, K., K. Pfeiffer, J. Almeida, M. Dowda, and R. Pate. Validity of the Actigraph and Actical Acclerometers in 3–5 year-old children. In: *North American Society for Pediatric Medicine*. New Brunswick, Canada: St. Andrews-by-the-Sea, 2004.
16. Medbo, J.I., A. Mamen, B. Welde, V. Von Heimburg, and R. Stokke. Examination of the Metamax I and II oxygen analysers during exercise studies in the laboratory. *Scand. J. Clin. Lab. Invest*. 62:585-598, 2002.
17. Mulvihill, C., K. Rivers, and P. Aggleton. *Physical Activity 'At Our Time'. Qualitative Research Among Young People Aged 5 to 15 Years and Parents*. London: Health Education Authority, 2000.
18. Nilsson, A., U. Ekelund, A. Yngve, and M. Sjoestroem. Assessing physical activity among children with accelerometers using different time sampling intervals and placements. *Pediatr. Exerc. Sci*. 14:87-96, 2002.
19. Norton, K., and T. Olds. *Anthropometrica*. Sydney, Australia: University of New South Wales Press, 1996.
20. The NPD Group. *Annual U.S. Video Game Sales: NPD Group Reports on Video Game Sales and Best Selling Video Game Titles.* Available at: http://retailindustry.about.com/od/seg_toys/a/bl_npd012703.htm. Accessed June 15, 2004.
21. Pratchett, R. *Gamers in the UK: Digital Play, Digital Life Styles*. London, England: BBC Audience Research, New Media, 2005.
22. Ridley, K., and T. Olds. Video center games: energy cost and children's behaviours. *Pediatr. Exerc. Sci*. 13:413-421., 2001.
23. Salmon, J., K. Campbell, and D.A. Crawford. Television viewing habits associated with obesity risk factors: a survey of Melbourne school children. *Med. J. Aust*. 184:64-67, 2006.
24. Segal, K., and W. Dietz. Physiological responses to playing a video game. *Am. J. Dis. Child*. 145:1034-1036, 1991.
25. Shaw, A., A. McMunn, and J. Field. *The Scottish Health Survey 1998, Volume No. 1*. Edinburgh: The Stationery Office, 2000.
26. Simons-Morton, B.G., N.M. O'Hara, G.S. Parcel, et al. Children's frequency of participation in moderate to vigorous physical activities. *Res. Q. Exerc. Sport*. 61:307-314, 1990.
27. Spadano, J.L., A. Must, L.G. Bandini, G.E. Dallal, and W.H. Dietz. Energy costs of physical activities in 12-y old girls: MET values and the influence of body weight. *Int. J. Obes*. 27:1528-1533, 2003.
28. Sport England. *Young People and Sport in England, 2002. A Survey of Young People and PE Teachers.* London: Sport England, 2003.
29. Sproston, K., and P. Primatesta. *Health Survey for England 2002—The Health of Children and Young People*. London: The Stationery Office, 2003.
30. Tan, B., A.R. Aziz, K. Chua, and K.C. Teh. Aerobic demands of the dance simulation game. *Int. J. Sports Med*. 23:125-129, 2002.
31. Trost, S.G. Objective measurement of physical activity in youth: current issues, future directions. *Exerc. Sport Sci. Rev*. 29:32-36, 2001.

32. Trost, S.G., R. Way, and A.D. Okely. Predictive validity of three Actigraph energy expenditure equations for children. *Med. Sci. Sports Exerc*. 38:380-387, 2006.
33. Unnithan, V.B., W. Houser, and B. Fernhall. Evaluation of the energy cost of playing a dance simulation video game in overweight and non-overweight children and adolescents. *Int. J. Sports Med*. 27:804-809, 2006.
34. U.S. Department of Health & Human Services. *A Healthier You: Dietary Guidelines for Americans.* Rockville, MD: The Department of Health and Human Services (HHS) and the Department of Agriculture (USDA), 2005.
35. Vanderwater, E.A., M. Shim, and A.G. Caplovitz. Linking obesity and activity level with children's television and video game use. *J. Adol*. 27:71-85, 2004.
36. Wang, X., and A.C. Perry. Metabolic and physiologic responses to video game play in 7- to 10-year-old boys. *Arch. Pediatr. Adolesc. Med*. 160:411-415, 2006.