

Combined Influence of Physical Activity and Screen Time Recommendations on Childhood Overweight

KELLY R. LAURSON, MS, JOEY C. EISENMANN, PHD, GREGORY J. WELK, PHD, ERIC E. WICKEL, PHD, DOUGLAS A. GENTILE, PHD,
AND DAVID A. WALSH, PHD

Objectives To examine the combined influence of physical activity and screen time (television and video games) on the odds of being overweight and to evaluate the utility of current public policy recommendations.

Study design Physical activity was assessed by a pedometer and screen time was assessed by survey in a sample of 709 children age 7 to 12 years. The percentage of subjects meeting current physical activity and screen time recommendations was calculated. Cross-tabulated physical activity–screen time groups were formed depending on whether or not the children were meeting current recommendations. Logistic regression was used to examine the influence of physical activity and screen time on the odds of being overweight.

Results Children meeting physical activity and screen time recommendations were the least likely to be overweight. Approximately 10% of the boys and 20% of the girls meeting both recommendations were overweight, compared with 35% to 40% of those who did not meet either recommendation. Screen time and physical activity appeared to be equivalent risk factors for boys, even though physical activity in girls was more strongly associated with body mass index.

Conclusions Children not meeting the physical activity or screen time recommendations were 3 to 4 times more likely to be overweight than those complying with both recommendations. (*J Pediatr* 2008;153:209-14)

A recent evidence analysis conducted by the American Dietetics Association identified physical activity levels and amount of screen time (i.e., television [TV] watching and video game [VG] playing) as predisposing factors for obesity.¹ Modifying these behavioral risk factors, along with diet, is a frequent objective of obesity interventions.²

Although some shared variance between physical activity and screen time has been reported,³ a change in screen time may have no impact on leisure-time physical activity,⁴ suggesting that these variables are separate constructs. But even though the independent associations between physical activity and overweight and between screen time and overweight are now fairly well established,¹ there is limited information on the combined influence of physical activity and screen time on the risk of being overweight in youth. A study using the Youth Risk Behavior Survey (YRBS) demonstrated the complexity of the interaction in cross-tabulated groups of adolescents identified with high, moderate, and low levels of physical activity and screen time.⁵ But the YRBS is limited by self-reported height and weight for determination of body mass index (BMI) and uses a single question to assess vigorous or moderate physical activity. Furthermore, the sample is limited to youth in grades 9 through 12 (age 14 to 18 years).

Public health experts and agencies often provide recommendations within policy statements as goals to aid in obesity prevention and intervention.^{6,7} These recommendations are usually formed based on a combination of expert opinion and existing evidence.⁸ But the initial risk of a child meeting or not meeting a recommendation or clinical cutpoint should be assessed to provide an indication of the utility of the cutpoint.^{9,10} The current screen time guideline from the American Academy of Pediatrics (AAP) recommends limiting children's total media time to no more 2 hours of quality programming per day.⁶ Targets of 13 000 and 11 000 pedometer steps/day for boys and girls, respectively,

From the Department of Health and Human Performance (K.L., J.E., G.W., E.W.) and Department of Psychology (D.G.), Iowa State University, Ames, IA and the National Institute on Media and the Family, Minneapolis, MN (D.G., D.W.).

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Reprint requests: Kelly Laurson, Department of Kinesiology, Iowa State University, 283 Forker, Ames, IA 50011. E-mail: klaurson@iastate.edu.

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AAP	American Academy of Pediatrics	TV	Television
BMI	Body mass index	VG	Video game
CI	Confidence interval	YRBS	Youth Risk Behavior Survey
OR	Odds ratio		

and physical activity cutpoints are endorsed by the President's Challenge Physical Activity and Fitness Awards Program^{11,12} and by the AAP within a policy statement on physical activity and childhood obesity.⁷

The purpose of the present study was to test the utility of current recommendations for physical activity and screen time. More specifically, we were interested in determining the combined influence of physical activity and screen time on the odds of being overweight in 7- to 12-year-old children.

METHODS

Subjects

The subjects were from public elementary schools in 2 midwestern communities (4 schools in Lakeville, Minnesota and 6 schools in Cedar Rapids, Iowa) involved in a community-, school-, and family-based childhood overweight and obesity intervention known as SWITCH. The data were collected before the subjects' knowledge of randomization into control or treatment groups (eg, baseline); thus, the study can be considered a cross-sectional, observational study design. Before study initiation, the procedures and risks of the research were explained verbally and in writing to all subjects and their primary caregivers, after which written assent was obtained from each subject and written consent was obtained from each primary caregiver. The study protocol was approved by the University of Minnesota's Human Subjects Review Board and is accordance with the Declaration of Helsinki.

Of the 2114 elementary school children invited to participate in the study, a total of 1360 accepted (64% response rate). But due to noncompliance with monitoring of physical activity or missing data for anthropometry or screen time, the final sample used in the current analysis comprised 709 children (318 boys and 391 girls). The composition of the sample for analysis is similar to the overall demographics of the school districts from which the children were enrolled.

Anthropometry

Standing height and body weight were measured by a school nurse according to standard procedures.¹³ Standing height was measured using a portable stadiometer (Seca Road Rod; Seca, Hamburg, Germany). Body mass was measured using a strain gauge scale (Lifesource MD; Lifesource, Milpitas, California). Measurement error was minimized by having the nurses participate in a training session before data collection; measurement error was determined during data collection through duplicate measures of every 25th subject. Overall, measurement error was small (standard error of the mean, 0.3 cm standing height and 0.1 kg body mass). BMI (in kg/m²) was calculated from measurements of standing height and body mass. Overweight and obesity were determined based on age- and sex-specific reference values developed by the International Obesity Task Force,¹⁴ which are anchored to adult values for overweight and obesity at age 18 years and extrapolated backward. For assessment of the odds of being

overweight, the children in the overweight and obesity groups were combined and are hereinafter referred to as overweight.

Screen Time

Average daily screen time was assessed by survey, based on procedures described previously.^{15,16} To quantify screen time, the children indicated how much time they spent watching TV during 3 time periods: from waking until lunch, from lunch until dinner, and from dinner until bedtime. This series of 3 questions was asked first for a typical school day and then for a typical weekend day, allowing calculation of a weekly estimate. This same procedure was repeated for VG playing, producing a weekly estimate of screen time that included both TV watching and VG playing. This measurement approach has proven reliable in previous studies¹⁵⁻¹⁷ and demonstrates appropriate predictive validity by predicting theoretically relevant variables, such as school performance. Furthermore, in the present sample, the 6-month test-retest Pearson correlations were high, averaging 0.50 for TV time, 0.52 for VG time, and 0.55 for total screen time (all $P < .001$). Total screen time was characterized using the AAP guideline recommending limiting children's total media time (entertainment media) to no more than 2 hours of quality programming per day.⁶

Habitual Physical Activity

Habitual, free-living physical activity was assessed using a pedometer (Digiwalker SW-200), which has proven to be suitable for research purposes.¹⁸ Each subject was instructed how to wear the pedometer during the day, and the pedometer's accuracy was verified before data collection began. The subject recorded the times at which the pedometer was worn and the number of steps accumulated each day over a 7-day period. Previous research supports a 4-day monitoring period to determine habitual physical activity.¹⁹ In addition, potential bias between weekend and weekday step counts must be accounted for.²⁰ For these reasons, a subject was included in the analysis only if he or she wore the pedometer for at least 10 hours on at least 4 days (3 weekdays and 1 weekend). Classification of physical activity was based on a norm-referenced criterion suggested by Vincent and Pangrazi¹¹ (13 000 steps/day for boys and 11 000 steps/day for girls) and endorsed by the AAP.⁷

Statistical Analysis

Descriptive statistics were calculated for the total sample and separately by sex. To assess relationships among variables of interest, partial correlations were conducted for boys and girls among pedometer steps/day, TV time/day, VG time/day, and BMI, controlling for chronological age. Initial logistic regression models were used to assess the utility of the current screen time and physical activity cutpoints independently. The children were categorized into 4 groups based on compliance with the physical activity and/or screen time recommendations: (1) do not meet physical activity/do not meet

Table I. Descriptive statistics

Variable	Boys (n = 318)	Girls (n = 391)	Total (n = 709)
Age, years	9.7 (0.9)	9.6 (0.9)	9.7 (0.9)
Height, cm	138.5 (7.2)	138.0 (8.1)	138.2 (7.7)
Weight, kg	35.3 (8.4)	35.6 (9.9)	35.5 (9.2)
BMI, kg/m ²	18.2 (3.1)	18.5 (3.6)	18.4 (3.4)
Overweight, %	18.9%	20.5%	19.7%
Obese, %	5.3%	9.2%	7.5%
Pedometer, steps/day	12 791 (3332)	10 871 (2565)	11 733 (3084)
Meeting activity recommendation, %*	41.8%	45.5%	43.9%
TV time, hours/day	2.9 (2.2)	2.8 (2.0)	2.8 (2.1)
VG time, hours/day	1.6 (1.7)	0.7 (1.1)	1.1 (1.4)
Total screen time, hours/day	4.5 (3.4)	3.5 (2.6)	4.0 (3.0)
Meeting 2-hour screen time recommendation, %†	26.7%	35.0%	31.3%

Values are reported as mean (standard deviation) unless noted otherwise.

*Vincent and Pangrazi (2002).

†AAP (2001).

screen time (ie, not meeting either the physical activity or screen time recommendations), (2) meet physical activity/do not meet screen time, (3) do not meet physical activity/meet screen time, and (4) meet physical activity/meet screen time. Within these groups, the frequency of overweight was calculated. Finally, logistic regression was used to calculate the odds of being overweight for each group. The high-physical activity/low-screen time groups were considered the referent for all analyses. Models were run separately by sex, adjusting for age. Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated using SAS version 9.1 (SAS Institute, Cary, North Carolina).

RESULTS

Descriptive statistics for physical characteristics, physical activity, and screen time are reported in Table I. For both boys and girls, the mean standing height approximated the 50th percentile for age- and sex-specific reference values, and mean body mass and BMI approximated the 75th percentile for age- and sex-specific reference values.²¹ No significant sex-based differences in age, height, body mass, BMI, or the combined prevalence of overweight and obesity were seen. Approximately 24% of the boys and 30% of the girls were classified as overweight or obese. Slightly less than 50% of the children met current pedometer-determined physical activity recommendations; approximately 27% of the boys and 35% of the girls met the AAP 2-hour screen time limit.

Partial correlations (controlling for age) among BMI, physical activity, and screen time are given in Table II. In general, correlations between physical activity, screen time, and BMI were low ($r < 0.30$). The associations between physical activity and BMI were similar for the boys and the girls. The correlations between screen time and BMI were slightly higher in the boys compared with the girls. Correlations for TV time were slightly higher than those for VG time and BMI. The correlation between VG time and BMI in the girls was not statistically significant. The correlations between

physical activity and screen time were low ($r < 0.11$) and not significant for either sex.

Logistic regression examining the independent association of physical activity and overweight indicated that boys accumulating fewer than 13 000 steps per day were 2.74 times more likely to be overweight than those that met the recommendation (95% CI = 1.54, 4.88), and girls who took fewer than 11 000 steps per day were 2.37 times more likely to be overweight than those who met the recommendation (95% CI = 1.50, 3.75). In terms of screen time, boys exceeding the recommended 2 hours of total screen time were 1.69 times more likely to be overweight than with ≤ 2 hours (95% CI = 0.90, 3.17), and girls with > 2 hours of total screen time were 1.22 times more likely to be overweight than those with ≤ 2 hours (95% CI = 0.77, 1.94).

Results of logistic regression on physical activity and screen time using the 2-hour AAP screen time recommendation are shown in Table III. The boys and girls who did not meet either recommendation were approximately 4.5 and 3 times more likely to be overweight than those meeting both recommendations, respectively. Boys who met only 1 of the cutpoints had an increased likelihood of being overweight; however, the ORs were not statistically significant. For girls meeting only 1 guideline, failing to meet the physical activity guideline resulted in a larger OR compared with that associated with exceeding the screen time recommendation.

DISCUSSION

The present study has considered the simultaneous influence of 2 key risk factors for childhood overweight using established public health recommendations. We found that children not meeting the physical activity or screen time recommendations were 3 to 4 times more likely to be overweight than those complying with both recommendations. Furthermore, those meeting the physical activity and screen time recommendations were the least likely to be overweight. Approximately 10% of the boys and 20% of the girls who met

Table II. Partial correlations among BMI, physical activity, and screen time

Variable	BMI	Physical activity	TV time	VG time	Total screen time
Boys (n = 318)					
BMI	1	—	—	—	—
Physical activity	-0.25	1	—	—	—
TV time	0.24	-0.11	1	—	—
VG time	0.14	-0.03	0.49	1	—
Total screen time	0.22	-0.09	0.90	0.82	1
Girls (n = 391)					
BMI	1	—	—	—	—
Physical activity	-0.29	1	—	—	—
TV time	0.14	-0.05	1	—	—
VG time	0.06	-0.04	0.39	1	—
Total screen time	0.13	-0.06	0.93	0.71	1

Correlations are adjusted for age. The correlations in boldface type are statistically significant ($P < .05$).

Table III. Influence of physical activity and screen time (2-hour recommendation) on the odds of being overweight

Meet physical activity recommendation	Meet screen time recommendation*	n (% of sample)†	Adjusted OR‡	95% CI
Boys (n = 318)				
Yes	Yes	38 (11.9%)	Referent	—
No	Yes	47 (14.8%)	2.60	0.75, 8.94
Yes	No	95 (29.9%)	1.59	0.49, 5.15
No	No	138 (43.4%)	4.39	1.47, 13.12
Girls (n = 391)				
Yes	Yes	63 (16.1%)	Referent	—
No	Yes	74 (18.9%)	2.56	1.14, 5.73
Yes	No	115 (29.4%)	1.32	0.60, 2.89
No	No	139 (35.5%)	3.00	1.44, 6.26

*AAP (2001).

†Percentage of logistic regression sample.

‡OR adjusted for age.

both guidelines were overweight. In comparison, 35% to 40% of the children who did not meet either recommendation were overweight (Figure). These results demonstrate the utility of these recommendations with regards to childhood overweight.

Although several studies have shown independent associations between physical activity and screen time and childhood overweight,¹ there is very limited information on the combined influence of these variables on odds of child overweight. Using data from the National Health and Nutrition Examination Survey, Anderson et al²² demonstrated that children grouped as watching more TV and participating in lower amounts of vigorous physical activity (ie, high TV time and low physical activity) had greater skinfold thickness measurements and BMI compared with other cross-tabulated groups; however, stronger associations were found for TV time. In the YRBS, Eisenmann et al⁵ found similar results for moderate physical activity, vigorous physical activity, and TV time, with stronger associations noted in girls. Comparing these results is somewhat difficult given the different classi-

fication scheme, but in general meeting the physical activity recommendation appeared to be more strongly associated with a reduced likelihood of overweight, especially in girls. In addition, TV time, VG time, and total screen time had a greater impact on the odds of being overweight for boys, possibly due in part to the fact that boys spend significantly more time playing VGs than girls.^{15,16}

A likely reason for the disparity between previous findings and our findings in terms of physical activity is the different methods used to assess physical activity. A meta-analysis by Rowlands et al²³ suggested that the relationship between physical activity and adiposity depends on the method of measurement; more specifically, studies using objective assessment tools show stronger results, which appears to be true in the present study. In the studies of Anderson et al²² and Eisenmann et al,⁵ physical activity was assessed through a single-item questionnaire. The use of the pedometer in the current study may have provided more consistent results and thus indicated stronger associations.

Some variation was seen in the estimated odds of being

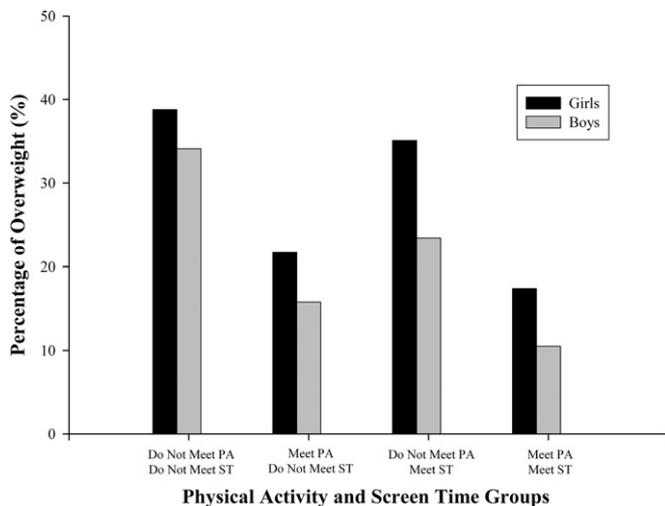


Figure. Percentage of overweight children in the various physical activity and screen time groups.

overweight between the boys and the girls. Not meeting the screen time cutpoint had little impact on the odds of being overweight for those girls who met the physical activity cutpoint. This finding may indicate that physical activity is a more important risk factor for overweight than screen time in girls. As also indicated by the correlations, the association between screen time and BMI ($r = 0.13$) was weaker than the association between physical activity and BMI ($r = -0.29$) in the girls. In the boys, the 2 risk factors had a similar relationship with BMI ($r \approx 0.20$ to 0.25). The reason for the sex difference in the associations between the 2 risk factors and BMI may be multifactorial. Considering the mean age of the girls in the current study (9.6 years), many of them are likely at the start of adolescence, at which physical activity typically sharply declines.²⁴ The importance of girls maintaining physical activity during this period has been documented.²⁵ This decline could have resulted in our finding that the association of physical activity overshadowed that of screen time in the girls. In addition, the boys in the current study watched more TV and played more VGs than the girls. This indicates that perhaps screen time accounts for a significantly larger portion of the boys' daily activity and thus is more strongly associated with weight status.

Relatively few children in this sample complied with the recommendations for physical activity or screen time. We previously reported the results for physical activity recommendations.²⁶ In the current study, several of the boys met at least 1 of the 2 recommendations; however, almost 50% of the boys did not meet either recommendation. In comparison, just over 33% of the girls failed to meet both cutpoints. This is likely because the girls watched less TV and especially spent less time playing VGs than the boys. These data are very similar to those reported from other studies;^{15,27,28} for example, in a sample of 430 third- to fifth-grade children, 29% of the girls had < 2 hours of total screen time daily, compared with only 13% of the boys.¹⁵

A strength of the current study is its unique design,

which simultaneously examined the influence of 2 common risk factors for child overweight using established guidelines supported and advocated by pediatricians. Even though clinical guidelines are generated using existing evidence, reaffirming these guidelines through independent analysis can provide practical information for clinicians, researchers, and policy makers.⁹ In addition, given the multifactorial nature of childhood obesity, investigating multiple risk factors simultaneously is often necessary to gain better insight into the complexity of this disorder.

Given the cross-sectional design of the current study, it is not possible to discern whether not meeting a current recommendation is the cause or the outcome of weight status. A prospective cohort study would allow for the determination of the future risk of being overweight in children who do not meet these recommendations at baseline and throughout the study period. Another limitation of this study is the self-reporting measure of TV, VG, and total screen time. Objective monitoring of screen time was not feasible. However, in the present sample, children reported spending approximately 20 hours per week watching TV and an additional 8 hours per week playing VGs. Combining the TV and VG times yields an approximate average of 28 hours per week of screen time. This is similar to the most recent published national average of 30.6 hours per week of screen time for 8- to 10-year olds.²⁷ One other limitation of the current study is the wide confidence intervals associated with the point estimates of the logistic regression. Large confidence intervals indicate decreased accuracy of the prediction and are due in part to the small number of overweight children in some of the physical activity/screen time groups, particularly the referent groups. But the confidence intervals likely are also due to the variation in the relationships among physical activity, screen time, and BMI (ie, childhood overweight is associated with more factors besides physical activity and screen time behaviors). Relatively few of the children who complied with both the physical activity and screen time recommendations were overweight. Screen time and physical activity appeared to be equivalent risk factors in the boys, even though in the girls physical activity was more strongly associated with BMI. Testing these recommendations in an independent sample indicates the utility of the current recommendations and the relationship between these behavioral risk factors and childhood obesity.

REFERENCES

1. Myers EF. ADA evidence analysis library. *J Am Diet Assoc* 2005;105:S79.
2. Sharma M. School-based interventions for childhood and adolescent obesity. *Obes Rev* 2006;7:261-9.
3. Eisenmann JC, Bartee RT, Wang MQ. Physical activity, television viewing and weight status in US adolescents: results from the 1999 YRBS. *Obes Res* 2002;10:379-85.
4. Taveras EM, Field AE, Berkey CS, Rifas-Shiman SL, Frazier AL, Colditz GA, et al. Longitudinal relationship between television viewing and leisure-time physical activity during adolescence. *Pediatrics* 2007;119:e314-9.
5. Eisenmann JC, Bartee RT, Smith DT, Welk GJ, Fu Q. Combined influence of physical activity and television viewing on the risk of overweight in US youth. *Int J Obes* 2008; doi:10.1038/sj.ijo.0803800.
6. American Academy of Pediatrics. Children, adolescents, and television. *Pediatrics* 2001;107:423-6.
7. Council on Sports Medicine and Fitness and Council on School Health. Active

healthy living: prevention of childhood obesity through increased physical activity. *Pediatrics* 2006;117:1834-42.

8. Shekelle PG, Woolf SH, Eccles M, Grimshaw J. Clinical guidelines: developing guidelines. *BMJ* 1999;318:593-6.
9. Shekelle P, Eccles MP, Grimshaw JM, Woolf SH. When should clinical guidelines be updated? *BMJ* 2001;323:155-7.
10. Swinburn B, Gill T, Kumanyika S. Obesity prevention: a proposed framework for translating evidence into action. *Obes Rev* 2005;6:23-33.
11. Vincent SD, Pangrazi RP. An examination of the activity patterns of elementary school children. *Pediatr Exerc Sci* 2002;14:432-41.
12. President's Council on Physical Fitness and Sports. The President's challenge physical activity and fitness awards program. In: President's Council on Physical Fitness and Sports. Bloomington, IN: US Department of Health and Human Services; 2001.
13. Malina RM. Anthropometry. In: Maud PJ, Foster C, editors. *Physiological Assessment of Human Fitness*. Champaign, IL: Human Kinetics; 1995. p. 205-19.
14. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: an international survey. *BMJ* 2000;320:1240-3.
15. Anderson CA, Gentile DA, Buckley KE. *Violent Video Game Effects on Children and Adolescents: Theory, Research, and Public Policy*. Oxford, UK: Oxford University Press; 2007.
16. Gentile DA, Lynch PJ, Linder JR, Walsh DA. The effects of violent video game habits on adolescent hostility, aggressive behaviors, and school performance. *J Adolesc* 2004;27:5-22.
17. Gentile DA, Walsh DA. A normative study of family media habits. *J Appl Dev Psychol* 2002;23:157-78.
18. Schneider PL, Crouter SE, Bassett DR. Pedometer measures of free-living physical activity: comparison of 13 models. *Med Sci Sports Exerc* 2004;36:331-5.

19. Trost SG, Pate RR, Freedson PS, Sallis JF, Taylor WC. Using objective physical activity measures with youth: how many days of monitoring are needed? *Med Sci Sports Exerc* 2000;32:426-31.
20. Duncan JS, Schofield G, Duncan EK. Pedometer-determined physical activity and body composition in New Zealand children. *Med Sci Sports Exerc* 2006;38:1402-9.
21. Ogden CL, Kuczmarski RJ, Flegal KM, Mei Z, Guo S, Wei R, et al. Centers for Disease Control and Prevention 2000 growth charts for the United States: improvements to the 1977 National Center for Health Statistics version. *Pediatrics* 2002;109:45-60.
22. Andersen RE, Crespo CJ, Bartlett SJ, Cheskin LJ, Pratt M. Relationship of physical activity and television watching with body weight and level of fitness among children: results from the Third National Health and Nutrition Examination Survey. *JAMA* 1998;279:938-42.
23. Rowlands AV, Ingledeu DK, Eston RG. The effect of type of physical activity measure on the relationship between body fitness and habitual physical activity in children: a meta-analysis. *Ann Hum Biol* 2000;27:479-97.
24. Kimm SY, Glynn NW, Kriska AM, Barton BA, Kronsberg SS, Daniels SR, et al. Decline in physical activity in black girls and white girls during adolescence. *N Engl J Med* 2002;347:709-15.
25. Koplan JP, Liverman CT, Kraak VI. Preventing childhood obesity: health in the balance. Executive summary. *J Am Diet Assoc* 2005;105:131-8.
26. Eisenmann JC, Laurson KR, Wickel EE, Gentile D, Walsh D. Utility of pedometer step recommendations for predicting overweight in children. *Int J Obes (Lond)* 2007;31:1179-82.
27. Rideout V, Roberts DF, Foehr UG. *Generation M: Media in the Lives of 8- to 18-Year-Olds*. Menlo Park, CA: Kaiser Family Foundation; 2005.
28. Rideout V. *Parents, Children and Media: A Kaiser Family Foundation Survey*. Menlo Park, CA: Kaiser Family Foundation; 2007.