Physical Education in Elementary School and Body Mass Index: Evidence from the Early Childhood Longitudinal Study

Ashlesha Datar, PhD, and Roland Sturm, PhD

Objectives. We examined the effect of physical education instruction time on body mass index (BMI) change in elementary school.

Methods. We examined data from a national sample of 9751 kindergartners in the United States who were reported on for 2 years. We used a difference-in-differences approach to examine the effect of an increase in physical education instruction time between kindergarten and first grade on the difference in BMI change in the 2 grades, using the same child as the control.

Results. One additional hour of physical education in first grade compared with the time allowed for physical education in kindergarten reduces BMI among girls who were overweight or at risk for overweight in kindergarten (coefficient = –0.31, $P < .001$) but has no significant effect among overweight or at-risk-for-overweight boys (coefficient = –0.07, $P = .25$) or among boys (coefficient = 0.04, $P = .31$) or girls (coefficient = 0.01, $P = .80$) with a normal BMI.

Conclusions. Expanding physical education programs in schools, in the form in which they currently exist, may be an effective intervention for combating obesity in the early years, especially among girls. (*Am J Public Health.* 2004;94:1501–1506)

Children spend many hours in school, making physical education (PE) programs in schools a potentially important channel through which physical activity and fitness may be promoted among young children.[1,2]

How effective are school PE programs in preventing obesity and promoting physical activity? Research studies tend to paint a pessimistic picture. Although guidelines recommend that students have daily classes, receive a substantial percentage of their weekly amount of in-school physical activity in PE classes, and be physically active for at least half of the PE class time, only a small minority of children have daily classes, and active class time is far below 50%.[3–7] In response, a number of programs have been developed to improve physical education, often in combination with other health education or environmental interventions.[8–12] Some intervention trials have indeed demonstrated that carefully designed programs can improve youth fitness and may reduce obesity.[10,13] However, no national study has evaluated the role of PE classes—in the form in which they are currently implemented in American schools—in preventing obesity. Even if actual classes fall short of standards or exemplary programs, their overall role may be more important for public health than the incremental addition to the baseline that possible interventions could provide.

We evaluated the effect of currently existing PE programs in US elementary schools by following a nationally representative cohort of kindergartners in the United States. The longitudinal data allowed us to study whether increases or decreases in physical education over time affect changes in body mass index (BMI).

METHODS

Analysis Sample

We analyzed data from the Early Childhood Longitudinal Study–Kindergarten Class (ECLS-K). The ECLS-K study was conducted by the National Center for Educational Statistics. The ECLS-K started surveying a nationally representative cohort of children (from about 1000 schools) who entered kindergarten in the 1998–1999 school year. The ECLS-K employed a multistage probability sample design to select the sample—the primary sampling units were geographic areas consisting of counties or groups of counties, the second-stage units were schools within the sampled primary sampling units, and the third-stage (and final) units were students within schools. (See the National Center for Educational Statistics ECLS-K Base Year Data Files and Electronic Codebook[14] for more information on the survey design and instruments.) This cohort was followed until grade 5, with surveys of the full sample in the fall and spring of kindergarten and in the spring of first, third, and fifth grades. As of summer 2003, data on the full sample of children from waves 1 (fall kindergarten), 2 (spring kindergarten), and 4 (spring first grade) had been released for public use, and we used data from these 3 waves for our analysis.

We used data from the child (height and weight), parent (family characteristics), teacher (PE exposure), and school questionnaires. About 19 028 children had valid height/weight data at baseline. About 5177 were missing follow-up data in waves 2 and 4. Of these, 3452 children were missing follow-up data because they moved away and were not followed. Because the ECLS-K only followed a random 50% sample of movers (presumably owing to cost concerns), the missing data among children who were followed are thus less likely to lead to bias. An additional 3640 children were lost because of nonresponse on their teacher, parent, or school questionnaires. About 10 211 children had all measures at all waves, but we deleted 460 observations because of data inconsistencies over time. These inconsistencies included problems such as change in BMI being more than 10 points during kindergarten and more than 15 points during first grade, BMI of either less than 11 or more than 30 in any wave, decrease in height over time, increase in height of more than 10 inches during first grade, and change in weight of more than 30 pounds. These changes are most likely errors in data entry. This resulted in an analysis sample of 9751 kindergartners. Comparison of children miss-

ing data at follow-up with those not missing data showed that children missing data at follow-up tended to be non-Whites and children with less educated mothers. However, there was no difference in baseline BMI between these 2 groups of children.

Measures

BMI. The key dependent variable is change in BMI, defined as weight in kilograms divided by the square of height in meters. The ECLS study team measured height and weight twice in each wave with the Shorr Board (Shorr Productions, Olney, Md) and a digital bathroom scale. If the 2 recorded height values were less than 2 inches apart, the average of the 2 height values was computed and used as the composite measure of height. Otherwise, the value that was closest to 43 inches (the average height for a 5-year-old child) was used as the composite. For the weight composite, if the 2 weight values from the instrument were less than 5 pounds apart, the average of the 2 values was computed. Otherwise, the value that was closest to 40 pounds (the average weight for a 5-year-old child) was used as the composite value.

Children that had a BMI greater than or equal to the 95th percentile for their age and gender were classified as overweight, and those with a BMI greater than or equal to the 85th percentile but less than the 95th percentile for their age and gender were classified as at-risk-of-overweight.

Because BMI was collected in each wave, we computed the change in BMI during kindergarten (difference between BMI at fall kindergarten and spring kindergarten) and the change in BMI during first grade (difference in BMI during spring kindergarten and spring first grade). The difference between BMI change in kindergarten and first grade is used as the dependent variable in our analyses. This dependent variable is adjusted for the difference in duration between waves 1 and 2 and waves 2 and 4. Changes in BMI could be caused by changes in the child's height or weight. BMI can decrease because of actual weight decreases, but in this population, BMI most commonly decreases because children grow substantially and gain relatively less weight. BMI increases were mainly the result of children gaining relatively more weight than height.

Exposure to physical education. Information on the number of times during the week and minutes per day that children were exposed to PE instruction was collected in spring kindergarten and first grade. This information was used to construct the change in hours per week of PE class time between kindergarten and grade 1.

Other explanatory variables. In multivariate models, we include gender, race/ethnicity, mother's education, percentage minority in school, school size, degree of urbanization of child's residence, measure of parent–child interaction, birthweight, change in the number of hours spent watching television or video tapes in a day between spring kindergarten and first grade, and whether the child belonged to a single-parent family as additional explanatory variables.

Data Analysis

Our main approach identified the effect of physical education by studying how a child's BMI changes over a year differ with changes in exposure to physical education. In contrast to this difference-in-differences approach, a more common cross-sectional analysis would have compared children's BMI (or BMI change over a period) by their exposure to physical education at a point in time and would use the variation across schools as identifying information. Although cross-sectional analyses are often the only available choice, errors may occur because schools in wealthy neighborhoods may have the resources to provide more PE programs, but children in these schools may also have more health-conscious parents or live in environments that promote healthy lifestyles outside school. It is unlikely that even comprehensive measurement could have captured all confounding effects.

The difference-in-differences approach reduced the problem of unmeasured characteristics by using children as their own control and employing the variation that comes from changes in PE class schedules over time, but within the same school. In our conceptual model, physical activity class time in a school year affects a child's change in BMI over the school year. BMI change is also affected by other characteristics of the school or child. By calculating the difference of 1-year changes in BMI over 2 school years and regressing this difference on the change in PE class time between 2 school years, any constant effects resulting from school or the socioeconomic environment were completely eliminated, regardless of whether we could measure the variables associated with these effects.

Statistically, we used a multivariate linear regression model with the difference of kindergarten–first grade BMI change as the dependent variable and with change in PE class time as the main explanatory variable. Calculating differences does not completely remove time-varying effects, which is why we included gender, race/ethnicity, mother's education, percentage minority in school, school size, degree of urbanization of school district, measure of parent–child interaction, birthweight, and whether the child belonged to a single-parent family as regressors. Although these variables were constant, they would only have cancelled out when calculating differences if their effect on BMI change is the same in kindergarten and grade 1, which is a testable hypothesis. The time-varying effect of changes in time spent watching television or videos was captured by the change in the number of hours spent watching television or video in a day between spring kindergarten and first grade. Finally, we also include the child's age in spring kindergarten in our models to control for naturally occurring changes in BMI by age. We used a school-level random effects model. This model corrected for the hierarchical structure (children are clustered in schools) by allowing for varying intercepts across schools. This specification accounted for the possibility that different schools may have had different trends in BMI change over time.

RESULTS

Table 1 reports the prevalence of overweight in kindergarten and first grade in our sample, by sociodemographic categories. Boys, non-Whites (in particular, Hispanic children), children whose mothers had an educational level of a high school diploma or less, and children from low-income families were significantly more likely to be overweight in kindergarten as well as first grade.

TABLE 1—Distribution of Overweight in Fall 1998 Kindergarten and Spring 2000 First Grade, by Child and Family Characteristics

	Percentage Overweight	
	Fall Kindergarten	Spring Grade 1
Gender		
Boys	11.6	12.6
Girls	9.8	11.8
Child's race/ethnicity		
White	9.6	10.6
Black	11.0	14.0
Hispanic	14.6	16.9
Asian	11.3	12.7
Other	10.6	12.6
Mother's education		
Less than high school	12.9	16.0
High school diploma	12.0	13.6
Some college	10.3	11.6
Bachelor's degree or more	8.2	9.0
Family income, $		
<15 000	11.6	14.6
15 000–24 999	13.3	16.0
25 000–34 999	14.7	15.0
35 000–49 999	10.5	12.3
50 000–74 999	9.9	10.5
≥75 000	7.6	8.8

Note. Overweight is defined as having a body mass index greater than or equal to the 95th percentile for age and gender.

TABLE 2—Distribution of Physical Education Instruction During Spring 1999 Kindergarten and Spring 2000 First Grade

	Kindergarten	Grade 1
Times per week, %		
Never	8.55	2.42
<1 time per week	4.26	3.53
1–2 times per week	58.7	65.32
3–4 times per week	12.09	16.19
Daily	16.4	12.54
Observations, no.	9751	9751
Minutes per day (conditional on some physical education), %		
1–15 minutes per day	11.36	5.41
16–30 minutes per day	63.64	56.62
31–60 minutes per day	24.85	37.9
>60 minutes per day	0.15	0.07
Observations, no.	8917	9515

Exposure to Physical Education in Kindergarten and First Grade

Table 2 reports the frequency (times per week) and duration (minutes per day) of PE class time in kindergarten and first grade, respectively. Among kindergartners, 16% received PE instruction in school daily, and 13% received PE instruction less than once a week or never. The majority of kindergartners (64%) had PE class time of between 16 and 30 minutes per day. Combining frequency and duration, kindergartners on average spent just under 1 hour per week (57 minutes per week) in PE class.

There was a significant increase in the average minutes per week of physical education between kindergarten and first grade (difference=8.2 minutes per week; $P<.001$). The median increase is much larger, from 34.5 minutes per week in kindergarten to 68.2 minutes per week in first grade. This large increase is largely explained by the bimodal distribution of minutes per week of PE instruction in kindergarten as well as first grade. Table 2 shows that most of the data are concentrated in the categories of either 16–30 or 31–60 minutes per day. Between kindergarten and first grade, there was a shift away from 16–30 and toward 31–60 minutes per day of physical education, resulting in a large increase in the median minutes per week of PE instruction. The first graders' weekly class time, based on the ECLS, was almost identical to the recent estimate of weekly PE class time for third graders, based on data from 10 sites,[3] indicating that there was little change in the average PE class time between first and third grade.

These average numbers obscure the variation in the change in curricula. Most schools increase PE time, but some schools also reduce PE time in first grade compared with kindergarten, and others have no PE classes in kindergarten and only start them in first grade. Overall, 37% of the children experienced an increase in PE instruction time between kindergarten and first grade and 44% maintained their kindergarten level of physical education. About 8% went from no physical education in kindergarten to some physical education during the week in first grade. Relatively fewer children experienced a reduction in minutes per week of physical education (19%), with only 2% of those who had physical education in kindergarten not receiving physical education in first grade.

Descriptive statistics (Table 3) show some differences in background characteristics by PE class time in kindergarten. Schools with no physical education in kindergarten had significantly fewer White ($P=.03$) and more Black children ($P<.001$), a higher percentage of families with income under $15 000 ($P=.02$), and a lower percentage of children with maternal education more than bachelor's degree ($P<.001$) or some college ($P=.05$). In addition, small schools ($P<.001$) and those with a greater percentage of minority students ($P<.001$) were more likely to offer no physical education in kindergarten.

PE Class Time and Changes in BMI

Table 4 reports the adjusted multivariate regression estimates of the effect of a 1-hour increase in PE instruction time on BMI change by gender and BMI category at baseline. PE instruction time has a strong negative effect on BMI change for girls who are overweight or at risk for overweight. We estimate that a 1-hour increase in PE instruction per week between kindergarten and first grade leads to a 0.31-point ($P<.001$) greater reduction in BMI in first grade compared with kindergarten among girls who were overweight or at risk for overweight. The effect of 1 hour of additional PE instruction per week was negative for boys who were overweight or at risk for overweight but was considerably smaller and not statistically significant (estimate=−0.07, $P=.25$). There is no effect for children with normal or low BMI in either girls (estimate=0.01, $P=.80$) or boys (estimate=0.04, $P=.31$).

Estimates of other covariates in these models were mostly statistically insignificant, indicating that time-varying effects of the school or socioeconomic environment were negligible and that our difference-in-difference approach removes the large (but constant) effects of sociodemographic and school

TABLE 3—Physical Education (PE) Instruction Time per Week During Kindergarten, by Continuous and Categorical Variables

	No PE Instruction	Some PE Instruction	*P* for Difference
Continuous Variables			
Body mass index (fall kindergarten)	16.32	16.25	.341
Body mass index (spring kindergarten)	16.41	16.33	.290
Body mass index (spring grade 1)	16.77	16.78	.969
Minutes/week of PE in first grade	55.11	66.18	.000
Hours/day of television or videos watched in kindergarten	2.17	2.00	.000
No. of activities that parents participated in with child	8.25	8.26	.836
Birthweight (pounds)	7.36	7.41	.281
Categorical Variables			
Percentage overweight (fall kindergarten)	0.12	0.11	.313
Percentage overweight (spring kindergarten)	0.12	0.10	.181
Percentage overweight (spring grade 1)	0.12	0.12	.924
Percentage at risk of overweight (fall kindergarten)	0.15	0.15	.698
Percentage at risk of overweight (spring kindergarten)	0.13	0.15	.086
Percentage at risk of overweight (spring grade 1)	0.15	0.14	.424
Belongs to single-parent family	0.23	0.18	.001
Female	0.50	0.50	.850
Child's race/ethnicity			
White	0.58	0.61	.032
Black	0.20	0.12	.000
Hispanic	0.15	0.16	.708
Other	0.08	0.11	.003
Mother's education			
Less than high school	0.13	0.12	.225
High school diploma	0.39	0.36	.059
Some college	0.30	0.27	.048
Bachelor's degree or more	0.18	0.26	.000
Family income, $			
< 15 000	0.16	0.13	.021
15 000–24 999	0.12	0.13	.411
25 000–34 999	0.15	0.12	.015
35 000–49 999	0.18	0.16	.113
50 000–74 999	0.21	0.23	.128
≥ 75 000	0.19	0.24	.003
Percentage minority in school less than 10%	0.26	0.38	.000
Less than 150 students enrolled in school	0.11	0.05	.000
Degree of urbanization of child's residence			
Central city	0.38	0.38	.846
Urban fringe/large town	0.41	0.39	.278
Small town/rural	0.21	0.23	.140
Observations	834	8917	

Note. Figures reported are percentages for categorical variables and means for continuous variables. Overweight and being at risk of overweight are defined as having a body mass index greater than or equal to the 95th percentile and between the 85th and 95th percentiles for age and gender, respectively.

characteristics. We also estimated unadjusted models that did not include any of the other covariates except the BMI group and change in PE variables (Table 4). These estimates were similar to those obtained from the adjusted models.

We also examined whether the effect of PE instruction time on BMI varied across different racial/ethnic groups, by including interactions of race with change in PE instruction time. We did not detect any statistically significant differences across race/ethnicity in the effect of physical education on BMI change among overweight or at-risk-for-overweight boys. Although the numbers were not quite statistically significant, it was estimated that White girls who were overweight or at risk for overweight may benefit more from increase in PE instruction time compared with other overweight or at-risk-for-overweight girls (estimate=−0.22, P=.05).

DISCUSSION

Despite the uneven reputation of currently existing PE programs in US schools, we found evidence that existing physical education can play a substantial role in containing obesity among overweight or at-risk-of-overweight girls. On the basis of our estimates, expanding existing PE instruction time nationwide so that every kindergartner gets at least 5 hours of PE instruction per week (close to the recommended levels) could decrease the prevalence of overweight among girls by 4.2 percentage points (43%) and the prevalence of children who are at risk for overweight by 9.2 percentage points (60%). Even if the true effect were at the lower bound of the confidence interval, reducing the change by about half, it would nevertheless be a very substantial change. The effect of physical education among heavier boys is much smaller and not statistically significant, and there is no effect among other children.

These simulations are derived from models that allow the relationship between physical education and BMI change to vary across normal BMI and overweight or at-risk-of-overweight children. These models take into account the possibility that physical activity benefits may be more pronounced when overweight children become active compared with when nonoverweight children become active, and our results support this hypothesis. However, within normal-BMI or overweight children, the relationship between physical education and BMI is assumed to be linear. It is also possible that physical activity benefits are more enhanced among sedentary children compared with active children. We tested for

TABLE 4—Estimated Change in Body Mass Index With 1 Hour of Additional Physical Education Instruction per Week, by Risk for Overweight, and Gender

	Body Mass Index Change	*P* (95% Confidence Interval)
Adjusted Model[a]		
Normal-weight children		
Boys only	0.041	.318 (–0.039, 0.121)
Girls only	0.010	.810 (–0.074, 0.095)
At-risk-for-overweight or overweight children		
Boys only	–0.068	.263 (–0.186, 0.051)
Girls only	–0.317	.000 (–0.459, –0.174)
Unadjusted Model[b]		
Normal-weight children		
Boys only	0.043	.298 (–0.038, 0.123)
Girls only	0.014	.742 (–0.070, 0.099)
At-risk-for-overweight or overweight children		
Boys only	–0.062	.307 (–0.180, 0.057)
Girls only	–0.312	.000 (–0.454, –0.170)

[a]Regressions included constant, gender, age in months at time of spring kindergarten, race/ethnicity, maternal education, family income, parent-child interaction, whether child belonged to a single-parent family, birthweight, change in hours of television watched per day between kindergarten and first grade, percentage minority in school, school size, and degree of urbanization of child's residence.
[b]Estimates are from models that only include constant, change in physical education between kindergarten and first grade, indicator for whether child was overweight or at risk of overweight at baseline, and interaction between change in physical education and the indicator variable for overweight or being at risk of overweight.

this in our model by including physical education in kindergarten and its interaction with change in physical education over time. The interaction effect was insignificant for both boys and girls, indicating that the effect of increased PE instruction between kindergarten and first grade did not differ by amount of physical education in kindergarten.

Similar to our findings, school-based interventions on middle school children, such as the Planet Health intervention, have also detected gender differences in the effectiveness of PE programs, with effects concentrated among girls rather than boys.[10,17] Although some of these gender differences may be explained by initial differences in activity levels of boys and girls (boys being more active than girls early in life), the 2 studies suggest that different causal factors may operate among boys and girls.[10] Otherwise, it is difficult to compare our study to prior publications because we try to answer a different research question. Most other research studies estimate the effect of new programs compared with "school as usual," whereas we are only interested in "school as usual." A review of school-based intervention programs, not just PE, found that the mean reduction in the percentage of children who were overweight across the 12 studies examined was about 10%,[13] with the largest effects estimated to be close to a 15% reduction in overweight.[18] On the basis of our estimates, a 10% reduction of overweight among girls could also be achieved by a nationwide expansion of existing elementary school PE programs by about 1 hour per week. Even using only the lower bound of the confidence intervals, expanding existing PE programs appears to be a very effective strategy to contain obesity among elementary school children, at least among girls.

Limitations

Although a national data set is a big advantage as far as generalizability (external validity) is concerned, we have an observational study, not a randomized trial, and internal validity is a concern. Purely cross-sectional analyses, such as regressing a child's BMI (or BMI change) on PE class time, are likely to be subject to unobserved confounding factors, including unmeasured family and school characteristics. Fortunately, we have longitudinal data, which is a big advantage in that situation. By examining how a change in exposure to physical education between kindergarten and first grade affected the difference in BMI change during first grade compared with kindergarten for the same child, all unobserved fixed factors correlated with both physical education and BMI were controlled. What was not controlled were unobserved characteristics correlated with BMI or PE if those effects change between kindergarten and first grade. Although we have large sample sizes compared with intervention trials, the statistical power for subgroup comparisons is limited. Even a substantial differential effect by race/ethnicity among girls is not statistically significant—a conclusion likely to change with larger sample sizes.

Conclusions

School boards are receiving mixed messages about physical education. On the one hand, government organizations like the Centers for Disease Control and Prevention recommend that all schools require physical education for all students from kindergarten through twelfth grade on a daily basis. On the other hand, the predominant conclusion emerging from research studies is that typical PE programs are substandard and of limited value. School boards, principals, and teachers facing other competing goals, especially academic achievement, may come away with the conclusion that if existing physical education is of limited value, it should be abolished or at least reduced in favor of academic instruction. In fact, our findings indicate that only 16% of kindergartners received PE instruction in school daily in 1998 and about 13% received PE instruction either less than once a week or never. However, far from being worthless, our study shows that "school as is" plays an important role in keeping obesity among girls in check and that expanding existing physical education in US elementary schools could reduce obesity rates among girls. ■

About the Authors

Ashlesha Datar and Roland Sturm are with the RAND Corporation, Santa Monica, CA.

Requests for reprints should be sent to Ashlesha Datar, PhD, RAND, 1700 Main Street, P.O. Box 2138, Santa Monica, CA 90407 (e-mail: datar@rand.org).

This article was accepted March 30, 2004.

Contributors

A. Datar and R. Sturm contributed to the study design, data analysis, and manuscript preparation. A. Datar contributed to the data collection.

Acknowledgments

This research was funded by National Institute for Health Care Management, a nonprofit, nonpartisan organization based in Washington, D.C.

Human Participant Protection

This research was exempt from institutional review board approval.

References

1. Carter RC. The impact of public schools on childhood obesity. *JAMA.* 2002;288(17):2180.

2. Centers for Disease Control and Prevention. Guidelines for school and community programs to promote lifelong physical activity among young people. *MMWR Morb Mortal Wkly Rep.* 1997;46:1–36.

3. Nader PR. Frequency and intensity of activity of third-grade children in physical education. *Arch Pediatr Adolesc Med.* 2003;157(2):185–190.

4. Simons-Morton BG, O'Hara NM, Parcel GS, Huang IW, Baranowski T, Wilson B. Children's frequency of participation in moderate to vigorous physical activities. *Res Q Exerc Sport.* 1990;61(4):307–314.

5. Simons-Morton BG, Taylor WC, Snider SA, Huang IW, Fulton JE. Observed levels of elementary and middle school children's physical activity during physical education classes. *Prev Med.* 1994;23:437–441.

6. Parcel GS, Simons-Morton BG, O'Hara NM, Baranowski T, Kolbe LJ, Bee DE. School promotion of healthful diet and exercise behavior: an integration of organizational change and social learning theory interventions. *J Sch Health.* 1987;57(4):150–156.

7. Centers for Disease Control and Prevention. Youth Risk Behavior Surveillance System (YRBSS): United States, 2001. *MMWR Morb Mortal Wkly Rep.* 2002; 51:1–62.

8. Sallis JF, McKenzie TL, Alcaraz JE, Kolody B, Hovell MF, Nader PR. Project SPARK: effects of physical education on adiposity in children. *Ann N Y Acad Sci.* 1993;699:127–136.

9. Sallis JF, Conway TL, Prochaska JJ, McKenzie TL, Marshall SJ, Brown M. The association of school environments with youth physical activity. *Am J Public Health.* 2001;91:618–620.

10. Gortmaker SL, Peterson K, Wiecha J, et al. Reducing obesity via a school-based interdisciplinary intervention among youth: planet health. *Arch Pediatr Adolesc Med.* 1999;153(4):409–418.

11. Donnelly JE, Jacobsen DJ, Whatley JE, et al. Nutrition and physical activity program to attenuate obesity and promote physical and metabolic fitness in elementary school children. *Obes Res.* 1996;4(3): 229–243.

12. McKenzie TL, Nader PR, Strikmiller PK, et al. School physical education: effect of the Child and Adolescent Trial for Cardiovascular Health Research. *Prev Med.* 1996;25(4):423–431.

13. Story M. School-based approaches for preventing and treating obesity. *Int J Obesity.* 1999(23, Suppl 2); S43–S51.

14. National Center for Educational Statistics. ECLS-K Base Year Data Files and Electronic Codebook. 1999. Available at: http://nces.ed.gov/pubs2001/2001029.pdf. Accessed on September 13, 2003.

15. Ogden CL, Flegal KM, Carroll MD, Johnson CL. Prevalence and trends in overweight among US children and adolescents, 1999–2000. *JAMA.* 2002; 288(14):1728–1732.

16. Kuczmarski RJ, Ogden CL, Guo SS, et al. 2000 CDC growth charts for the United States: methods and development. National Center for Health Statistics. *Vital Health Stat.* 2002;11(246).

17. Vandongen R, Jenner DA, Thompson C, et al. A controlled evaluation of a fitness and nutrition intervention program on cardiovascular health in 10–12 year old children. *Prev Med.* 1995;24(1):9–22.

18. Brownell KD, Kaye FS. A school-based behavior modification, nutrition education and physical activity program for obese children. *Am J Clin Nutr.* 1982;35: 277–283.