Ecological Predictors and Developmental Outcomes of Persistent Childhood Overweight

By Sara Gable, Jo Britt-Rankin, and Jennifer L. Krull,
University of Missouri, Columbia

Abstract

Child obesity poses short- and long-term health risks and may have negative social and economic consequences in adulthood. This study uses data on 8,000 children followed from kindergarten through third grade as part of the Early Childhood Longitudinal Study-Kindergarten Class to examine predictors of persistent childhood overweight and associated academic and socioemotional outcomes. Results show that socioeconomic status, gender, race, and behavioral and environmental factors influence risk of persistent overweight. The odds of children being overweight increased 3 percent for each additional hour of television that they watched per week and 9 percent for each family meal per week that they did not experience. Overweight children progressed less than their nonoverweight peers did in reading and math achievement, with overweight appearing to precede academic difficulties, and were rated lower on academic and socioemotional factors by their teachers and themselves. Academic and social costs should be considered in assessing costs of childhood overweight and potential benefits of overweight prevention.

Contents

Summary

What Is the Issue?

The rise in childhood overweight has raised concerns because of short- and long-term health consequences. Overweight children are at greater risk for high blood pressure and cholesterol, diabetes, orthopedic problems, and sleep apnea. If overweight persists and results in obesity in adulthood, increased physical health risks continue. In addition, obesity has been noted to have negative social and economic consequences for adolescents and young adults. This study examines predictors of persistent childhood overweight using data on 8,000 children followed from kindergarten through third grade as part of the Early Childhood Longitudinal Study-Kindergarten Cohort. Associated academic and socio-emotional outcomes were also assessed.

What Are the Major Findings?

Socioeconomic status, gender, and race all influenced risk of persistent overweight from kindergarten entry through third grade. As family socioeconomic status decreased, the odds of membership in the persistently overweight group increased. Of the two genders, boys were more likely to be members of the overweight group and, in comparison to White/Non-Hispanic children, children of American Indian backgrounds were also more likely to be overweight. Several significant gender by child race interactions also emerged. Specifically, African-American girls were more likely to be overweight than their White/Non-Hispanic female peers, and Hispanic and Asian boys were more likely to be overweight than their White/Non-Hispanic male peers.

Above and beyond socioeconomic and demographic factors, family and environmental factors also were significant. For example, for each additional hour of television children watched per

week, their odds of being overweight increased 3 percent and for each family meal per week that children did not experience, their risk for overweight increased 9 percent. Children living in neighborhoods rated by parents as less safe for outdoor play were also at increased risk of being persistently overweight.

Overweight children progressed less well than non-overweight peers on objective measures of reading and math achievement, with overweight appearing to precede academic difficulties. Overweight children also fared less well on teacher ratings of child academic abilities and social-emotional well-being, and gave poorer self-reports of interpersonal skills and internalizing symptoms.

Although many studies address the etiology and consequences of childhood overweight, few have examined persistently overweight children's developmental well-being and their experiences at home and at school over an extended period of time. This study furthers our understanding of the social and environmental correlates and multifaceted developmental costs of persistent overweight during childhood. These social and academic costs should be considered, along with physical health consequences, when assessing the overall costs of childhood overweight and the potential benefits of reducing overweight and obesity among the Nation's children.

How Was the Study Conducted?

The Early Childhood Longitudinal Study – Kindergarten Cohort (ECLS-K) followed a nationally representative sample of about 20,000 children who entered kindergarten in fall 1998 through

fifth grade. Data were gathered directly from children, parents/guardians, classroom teachers, and school administrators on a wide variety of child, parent, family, and school measures. For this project, children were selected for whom there were complete data on height and weight over 4 time points spanning the period from kindergarten entry to third grade spring. The comprehensive, longitudinal nature of the ECLS-K provides a unique opportunity to learn more about the etiology and developmental consequences of early appearing and persistent childhood overweight.

Introduction

The National Health and Nutrition Examination Survey reported that rates of *overweight*[1]

among children ages 6 to 19 have tripled over the past two decades (Ogden, Flegal, Carroll, and

Johnson, 2002), and, from 1999 to 2004, the percent of overweight children ages 6 to 11

increased significantly from 15% to 19% (Ogden, Carroll, Curtin, McDowell, Tabak, and Flegal,

2006).

Overweight during childhood is costly to individuals and is linked with chronic health

problems. Overweight children are at greater risk for Type 2 diabetes, high blood pressure and

cholesterol, orthopedic problems, and sleep apnea (Must and Strauss, 1999; Committee on

Prevention of Obesity in Children and Youth, 2005). If overweight persists and results in obesity

in adulthood, increased physical health risks continue. Along with physical health risks,

academic difficulties (e.g., Falkner et al., 2001), poor psychosocial health (Friedlander, Larkin,

Rosen, Palermo, and Redline, 2003; Schwimmer, Burwinkle, and Varni, 2003), behavior

problems (Lumeng, Gannon, Cabral, Frank, and Zuckerman, 2003), and social isolation among

peer networks (Strauss and Pollack, 2003) have also been noted to be problems associated with

child overweight.

Traditionally viewed as a health problem, current research shows clear associations between

weight problems and factors in the social and physical environment (Hill, Wyatt, Reed, and

Peters, 2003). In its simplest portrayal, overweight is an imbalance between energy intake and

---

[1] Throughout this report, unless otherwise noted, the terms childhood overweight or obesity are defined as a Body Mass Index (BMI; child weight in kilograms divided by height in meters squared) at or above the 95th percentile (Committee on Prevention of Obesity in Children and Youth, 2005).   Many experts prefer the use of the term "overweight" to "obesity" when describing the condition in children.

energy output. As straightforward as this seems, overweight is an extremely complex problem.

Consequently, experts contend that it is the most critical public health threat facing children

today (Committee on Prevention of Obesity in Children and Youth, 2005; Committee on

Progress in Preventing Childhood Obesity, 2007). Reducing the prevalence of children who are

overweight and obese has been identified as a Healthy People 2010 priority health objective by

the Federal government (U.S. Dept of Health and Human Services, 2000). Because of its role as

the lead Federal department for nutrition and its involvement in providing food assistance and

nutrition education to children and their families, the problem is of special importance to USDA

(USDA Food and Nutrition Service, 2000).

Because families play such an important role in socializing children's health beliefs and

behaviors (Sallis and Nader, 1988), identifying the family-related factors that are associated with

weight problems is crucial for effective prevention and treatment. Moreover, establishing the

multifaceted costs associated with overweight during the school-age years is critical to garnering

the attention and resources required for effective prevention and intervention programs. To

further our understanding of the etiology and outcomes of childhood overweight, two separate

studies were conducted; the first to identify the child and family eating and activity experiences

that distinguish overweight from non-overweight children and the second to assess the

relationship between persistent overweight and children's development, specifically their

academic achievement and social-emotional well-being.

Data and Methods

The Early Childhood Longitudinal Study – Kindergarten Class (ECLS-K)

The Early Childhood Longitudinal Study – Kindergarten Class (ECLS-K; West) has followed a nationally representative sample of about 20,000 children from kindergarten entry in fall 1998 through fifth grade. Conceived as a descriptive study of children's status when they began kindergarten and their progression through fifth grade, the study also affords the opportunity to explore timely questions related to children's development and well-being. Aside from the unusually large, representative sample, what distinguishes the ECLS-K is the study's ecologically and developmentally relevant design. The ECLS-K is guided by a multi-factor framework of children's development and addresses the multiple settings where children spend time and the key agents of socialization. Data are gathered directly from children, parents/guardians, classroom teachers, and school administrators on a wide variety of child, parent, family, and school measures. Subsequently, the comprehensive, longitudinal nature of the ECLS-K provides a unique opportunity to learn more about the consequences of early appearing and persistent childhood overweight.

For our project, we used data gathered at kindergarten fall and spring (T1 and T2), first-grade spring (T3), and third grade spring (T4). At each time point, the number of children who were directly assessed was T1 = 19,173, T2 = 19,967, T3 = 16,593, and T4 = 14,349. Children who weighed less than 2000 grams at birth (n = 473) or who received extensive therapeutic services prior to kindergarten entry (n = 780) were excluded from the study because these characteristics could by themselves explain the outcomes of interest. Additionally, children who were not in their first year of kindergarten (n = 801) and those children who repeated or skipped a grade (n = 935 at first grade; n = 1,325 at third grade) were deemed ineligible. Lastly, because the study focused on persistent overweight, only children with complete height and weight data from all 4 time points were included. Thus, both studies began with 8,459 participants (see Table 1 for a

complete description of the children and their families).

Child Overweight

For both studies, the 2000 Center for Disease Control Growth Charts: United States (Kuczmarski, Ogden, Guo et al., 2002) were used to categorize children on the basis of their Body Mass Index (BMI; child weight in kilograms divided by height in meters squared) as not overweight ($< 95^{th}$ percentile) or overweight ($\geq 95^{th}$ percentile). As shown in Table 2, the percent of children who were overweight at each timepoint was 12%, 11%, 13%, and 18%, respectively.

For Study 1, to investigate our research questions concerning the predictors and outcomes of early appearing and persistent childhood overweight, we identified two mutually-exclusive groups: *never overweight* and *overweight* (see Table 2). Thus, we excluded from analyses children who were intermittently overweight [n = 459 (5% of the original 8,459 participants); see Table 2 for details]. Children who were not overweight (i.e., at or above the 95th percentile of the Body Mass Index) at any of the 4 time points comprised the never overweight group (n = 6,643; 47% boys). Children who were overweight at all 4 time points, who became overweight and remained overweight during the last 2 or 3 time points, and children who were overweight at third grade spring comprised the overweight group (n = 1,357; 51% boys). Thus, data analyses focused on 8,000 children.

For Study 2, to investigate the outcomes of early appearing and persistent childhood overweight, we identified four mutually-exclusive overweight groups defined by onset of

overweight: *kindergarten*, *first grade*, *third grade only*, and *never overweight* (see Table 3). Children who were overweight at kindergarten fall or spring and whose overweight persisted through third grade were members of the *kindergarten* group (n = 757; 50% boys). Children who were not overweight during kindergarten but who were overweight at first grade spring and were overweight at third grade spring comprised the *first grade* group (n = 179; 48% boys). Children who were not overweight during kindergarten and first grade and who were overweight at third grade spring made up the *third grade only* group (n = 421; 54% boys). Children who were not overweight at any of the four time points comprised the *never overweight* group (n = 6,643; 47% boys). Lastly, we excluded from analyses children who were intermittently overweight [n = 459 (5% of the original 8,459 participants)]; thus, all analyses focused on 8,000 children. Mean Body Mass Index percentiles are presented for the four overweight groups at each time point in Table 3.

Study 1 and Study 2: Predictors and Outcomes

Study 1 used parent reports of children's eating and activity experiences to estimate the odds of being a member of the persistently overweight group (for a published version of portions of this study, see Gable, Chang, and Krull, 2007). Specifically, we considered child and family participation in USDA food and nutrition assistance programs (i.e., WIC, the School Breakfast and National School Lunch Programs, and the Food Stamp Program), children's television habits, time spent engaged in vigorous activity, opportunities for physical activity, frequency of family meals, and neighborhood safety for outdoor play.

Study 2 examined the effect of overweight on direct assessments of children's reading and math. In addition, it assessed teacher reports of children's socio-emotional well-being, including

approaches to learning, self-control, interpersonal skills, externalizing behaviors, such as fighting

and arguing, aggression toward people and objects, and general disobedience and internalizing

behaviors such as the expression of anxiety, loneliness, and sadness. Finally, children's self-

reports of their academic competence, social skills, and externalizing and internalizing symptoms

were examined. Results concerning the direct measures of children's academic achievement

appear in Gable, Krull, and Srikanta (2008) and a variation of the social-emotional findings are

currently under review for publication (Gable, Krull, and Chang, under review). Additionally,

some of the findings from Study 2 were presented at the annual Food Assistance Research:

Recent Findings and Emerging Issues conference. Economic Research Service, U.S. Department

of Agriculture, Washington, DC (Gable, 2006).

Analytic Approach

Because the ECLS-K data were collected using a multistage sample of kindergarten students

nested within schools, we used multilevel random coefficient models (MLM), a class of models

specifically designed for the analysis of clustered data structures, to explicitly acknowledge and

accommodate the clustered data structure and produce more accurate tests of effects

(Raudenbush and Bryk, 2002). For Study 1, an MLM analog of logistic regression (Goldstein,

1991; Goldstein and Rasbash, 1996) was performed using the SAS macro GLIMMIX to predict

our dichotomous outcome variable (persistent overweight versus non-overweight).

For Study 2, we used SAS PROC MIXED (Version 8) to estimate 3-level random coefficient

models, with error terms estimated at the school (or teacher) and child level, as well as the

residual variation across time (Raudenbush and Bryk, 2002; Singer, 1998). When models

revealed significant results involving child overweight, effect sizes were calculated in terms of

Cohen's *d*, as per Raudenbush and Xiao-Feng (2001), to reflect the magnitude of the group

differences.

For both studies, sample weights were used to produce estimates that are representative of the population of children attending kindergarten in 1998 – 1999. Additionally, both Study 1 and Study 2 controlled for the anticipated effects of child race and family socio-economic status.

Summary of Findings

Together, these studies yielded results that further our understanding of the etiology and outcomes of persistent childhood overweight.

Study 1: Predictors of Childhood Overweight

Study 1 identified several demographic correlates of childhood overweight. Specifically, boys are more likely to be members of the overweight group and, in comparison to White/Non-Hispanic children, children of American Indian backgrounds are also more likely to be overweight. Several significant gender by child race interactions also emerged. Specifically, African-American girls were more likely to be overweight than their White/Non-Hispanic female peers; and, Hispanic and Asian boys were more likely to be overweight than their White/Non-Hispanic male peers. And finally, family socioeconomic status was associated with child weight status; as SES decreased, the odds of membership in the persistently overweight group increased.

As presented in Table 4, our univariate analyses, each of which considered a single focal predictor and controlled for child and family demographics, showed that children who participated in WIC earlier in life (WIC eligibility ends at age 5) and who participated in the school lunch program, who watched more hours of television, ate fewer meals with their family, and lived in neighborhoods that parents reported were less safe for outdoor play were more likely

to be members of the persistently overweight group. In the univariate analyses, child participation in the school breakfast program, household participation in the food stamp program, and child aerobic exercise and exercise experiences were not associated with an increased likelihood of belonging to the persistent overweight group.

The final step was to conduct a multivariate, multilevel logistic regression model that included all variables that were significant at the univariate level. The final model, presented in Table 5, includes those predictors that remained significant when entered as a block. Child participation in WIC and the school lunch program became non-significant when entered with the other significant predictors and were thus trimmed from the final model. Children who watched more television (overweight group mean = 15.94 hours, SD = 6.74; never-overweight group mean = 14.12 hours, SD 6.40), ate fewer meals with their families (overweight group mean = 9.56 meals, SD = 2.61; never-overweight group mean = 10.26 meals, SD 2.56), and who lived in neighborhoods that are reported by parents as less safe for outdoor play (overweight group mean = 2.67, SD = 0.45; never-overweight group mean = 2.74, SD 0.40), were more likely to be members of the persistently overweight group. For example, for each additional hour of television children watched per week, their odds of being overweight increased 3 percent and for each family meal per week that children do not experience, their risk for overweight increased 9 percent.

Study 2: Academic and Social-Emotional Consequences of Childhood Overweight

Child Academic Achievement

Results for the multilevel individual growth models predicting direct assessments of children's academic achievement from kindergarten entry through third grade are shown in Table

6. In general, findings from the full models support our original hypothesis that overweight children's academic achievement differs from their never-overweight peers. Trajectories of children's academic abilities revealed effects of overweight that varied with time but were similar for overweight boys and girls. The significant overweight by time effect indicates that overweight children's academic abilities were increasingly diverging, in a downward fashion, from those of never overweight children at each subsequent timepoint (Appendix A contains unadjusted means and standard deviations for children's scores on the direct assessments of reading and math). When compared with their never-overweight peers, children who were overweight for the duration of the study performed more poorly on assessments of reading and math skills at first grade and third grade spring. For children who became overweight at first grade, their reading scores were lower than their never-overweight peers' scores at third grade and their math scores were lower at both first and third grade spring. Interestingly, the children who were overweight only at third grade exhibited academic skills that resembled their never-overweight peers. Together, the current findings suggest that overweight may precede academic difficulties for children between age 5.5 and 9.5 years. That is, after young, school-age children cross the threshold to clinical overweight (i.e., a body mass index at or above the 95th percentile), they are at risk for academic challenges, in this case, problems with reading and math.

Interestingly, as shown in Table 8, children's self perceptions of their school achievement did not necessarily correspond with the standardized reading and math assessments; only one effect of overweight emerged and it was moderated by child gender. Specifically, at the end of third grade, boys who were overweight only at third grade and girls who had been overweight since kindergarten both viewed their reading abilities more poorly than their never-overweight classmates. No other overweight effects emerged for children's views on their academic

abilities.

Child Social-Emotional Outcomes

Teacher ratings. Results from the multilevel individual growth models of teacher reports of child social-emotional well-being are presented in Table 7. Our findings concur with other studies of childhood overweight and psychosocial well-being: children with weight problems are not faring as well as their non-overweight peers (Falkner et al., 2001; Friedlander et al., 2003; Lumeng et al., 2003; Schwimmer et al., 2003; Strauss and Pollack, 2003). For instance, as shown in Figure 1, at all grade levels teachers rated children who were persistently overweight (i.e., the kindergarten group) and children who were to become overweight (i.e., the third grade only group) as showing less skill in taking advantage of the learning environment than their never-overweight peers.

Also shown in Table 7, several of the overweight effects were moderated by child gender. For teacher reports of child self-control, overweight effects were not significant for boys. However, as depicted in Figure 2, when compared to never-overweight females, those girls who were overweight from kindergarten until third grade and those girls who were overweight only at third grade spring were rated by teachers as showing less self-control. Overweight effects were also not significant for teacher ratings of boys' social skills. However, as shown in Figure 3, there were effects for girls. Whereas the time effects varied for the different groups of overweight girls, the main message is that overweight effects seemed to disappear for the persistently overweight girls and to worsen for girls in the third grade group over the course of the study. Indeed, for girls who were first overweight in the third grade, the overweight effects appeared prior to the onset of clinical overweight and worsened with time.

Teacher ratings of children's externalizing behaviors revealed an interaction among weight, gender, and time. As shown in Figure 4, the boys who had been overweight since kindergarten were rated as showing decreasing levels of externalizing behaviors. For girls, teachers rated the expression of externalizing behaviors similarly for the girls in the overweight and never-overweight groups at kindergarten entry. However, by first grade, differences between overweight and never-overweight girls emerged, particularly for girls who had been overweight since kindergarten and for girls who were to be overweight at third grade spring. By third grade spring, the differences disappeared for the girls who had been overweight since kindergarten and grew more pronounced for girls who were overweight only at third grade.

Teacher ratings of child internalizing behaviors revealed a significant overweight group by gender interaction. Whereas there was no effect of overweight for boys, as shown in Figure 5, girls who were overweight during kindergarten and remained so until third grade spring were rated by teachers as exhibiting more internalizing behaviors than their non-overweight female peers.

Child self-reports. Table 8 shows the findings from the multilevel models predicting children's third grade self-reports of their social-emotional well-being. For two subscales, overweight contributed significantly and in the expected direction to children's perceptions of themselves. Specifically, for children's self-reports of their interpersonal skills, the effect of overweight was significant for all three overweight groups. Regardless of when children's clinical overweight appeared, children rated themselves at third grade spring as having more trouble with social relationships than their never-overweight peers. Children's third-grade self-

reports of internalizing behaviors also showed overweight effects. Children in the kindergarten and first grade overweight groups reported more experiences of sadness, loneliness, and anxiety than their never-overweight peers at third grade. Overweight group did not play a role in children's self-reports of externalizing behaviors.

Significance

The current project contributes to our understanding of the potential causes and consequences of persistent childhood overweight. As prevalence rates climb, with no clear signs of abating, research must continue to identify windows of opportunity for intervention. Curbing the onset and maintenance of overweight is no easy task; overweight does not appear, or disappear, overnight.

The first study provides insights into strategies that may be employed by those seeking to reduce childhood obesity. Reducing television viewing and promoting family meals are education messages that have been employed by some nutrition education programs, such as the "Eat Better, Eat Together" campaign being conducted by the Washington State Nutrition Education Network, with funding support from USDA's Food and Nutrition Service. These findings support the value of these types of messages.

Moreover, to garner the attention and resources necessary to confront the problem, research must continue investigating the implications of weight problems for children's development and to document its costs. Although studies suggest that overweight interferes with quality of life in all domains, little is known about the developmental course of individuals who develop weight problems early in life. Some of the findings from Study 2 indicate that the distinction between

clinical overweight and larger-than-average body size is not germane to the prediction of poor outcomes, as negative effects precede the onset of clinical overweight, especially for girls of school age. Furthermore, for children who become and remain overweight early in the school years, the cumulative effects of small but significant decreases in school performance over time may have long term implications for a variety of outcomes associated with educational achievement. The 2006 release of the ECLS-K fifth grade data will permit follow-up investigation and evaluation of these trends. The studies conducted as part of this project thus strengthen the research base concerning the etiology and outcomes of childhood overweight.

References

Committee on Prevention of Obesity in Children and Youth. (2005). *Preventing childhood obesity: Health in the balance*. Washington, DC: National Academy Press.

Committee on Progress in Preventing Childhood Obesity (2007). *Progress in preventing childhood obesity: How do we measure up?* Washington, DC: National Academy Press.

Dietz, W. H. and Robinson, T.N. (1998). Use of the body mass index (BMI) as a measure of overweight in children and adolescents. The Journal of Pediatrics, 132(2), 191-193.

Falkner, N.H., Neumark-Sztainer, D., Story, M., Jeffery, R.W., Beuhring, T., and Resnick, M.D. (2001). Social, educational, and psychological correlates of weight status in adolescents. *Obesity Research*, *9(1)*, 32 – 42.

Friedlander, S. L., Larkin, E. K., Rosen, C. L., Palermo, T. M., and Redline, S. (2003). Decreased quality of life associated with obesity in school-aged children. Archives of Pediatric and Adolescent Medicine, 157, 1206 – 1211.

Gable, S. (February, 2006). *Effects of persistent obesity on human capital accumulation of school children.* Talk given at the annual Food Assistance Research: Recent Findings and Emerging Issues conference. Economic Research Service, U.S. Department of Agriculture, Washington, DC.

Gable, S., Krull, J. L., and Chang, Y. (under review). Implications of weight status for social and behavioral development between kindergarten entry and 3rd grade. The University of Missouri, Columbia.

Gable, S., Krull, J.L.,, Srikanta, A. (2008). Childhood overweight and academic achievement. In H.E. Fitzgerald and V. Mousouli (Eds.) *Obesity in America: Development and Prevention* (Vol 2; pp. 49 - 71). Westport, CT: Praeger Press.

Gable, S., Chang, Y., and Krull, J. L. (2007). Television watching and frequency of family meals are predictive of overweight onset and persistence in a national sample of school-age children. *Journal of the American Dietetic Association*, *107(1)*: 53-61.

Goldstein, H. (1991). Nonlinear multilevel models with an application to discrete response data. Biometrika, 78, 45-51.

Goldstein, H. and Rasbash, J. (1996). Improved approximations for multilevel models with binary responses. Journal of the Royal Statistical Society, Ser. A, 159, 505-513.

Gortmaker, S.L., Must, A., Perrin, J., Sobol, A.M., and Dietz, W.H. (1993). Social and economic consequences of overweight in adolescence and young adulthood. *New England Journal of Medicine, 329,* 1008-1012.

Hill, J. O., Wyatt, H. R., Reed, G. W., and Peters, J. C. (2003). Obesity and the environment:

Where do we go from here? Science, 299, 853-855.

Kuczmarski, R.J., Ogden, C.L., Guo, S.S., et al. (2002). 2000 CDC growth charts for the United States: Methods and development. National Center for Health Statistics. Vital Health Statistics, 11(246).

Lumeng, J.C., Gannon, K., Cabral, H.J., Frank, C.A., and Zuckerman, B. (2003). Association between clinically meaningful behavior problems and overweight in children. Pediatrics, 112, 1138-1145.

Must, A. and Strauss, R.S. (1999). Risk and consequences of childhood and adolescent obesity. International Journal of Obesity, 23(Suppl 2), S2-S11.

Office of Disease Prevention and Health Promotion, U.S. Department of Health and Human Services; *Healthy People 2010 http://www.healthypeople.gov/default.htm*

Ogden, C.L., Carroll, M.D., Curtin, L.R., McDowell, M.A., Tabak, C.J., and Flegal, K.M. (2006). Prevalence of overweight and obesity in the United States, 1999 - 2004. *Journal of the American Medical Association*, *295(13)*, 1549 - 1555.

Ogden, C.L., Flegal, K.M., Carroll, M.D., and Johnson, C.L. (2002). Prevalence and trends in overweight among U.S. children and adolescents, 1999 – 2000. Journal of the American Medical Association, 288(14), 1728 - 1732.

Raudenbush, S.W., and Bryk, A.S. (2002). *Hierarchical linear models: Applications and data analysis methods*. 2nd Edition. Sage Publications, Newbury Park: CA.

Raudenbush, S. W., and Xiao-Feng, L. (2001). Effects of study duration, frequency of observation, and sample size on power in studies of group differences in polynomial change. *Psychological Methods*, *6(4)*, 387-401.

Sallis, J.F. and Nader, P.R. (1988). Family determinants of health behaviors. In D.S. Gochman (Ed.), Health behavior: Emerging research perspectives. New York, NY: Plenum Press.

Schwimmer, J.B., Burwinkle, T.M., and Varni, J.W. (2003). Health-related quality of life of severely obese children and adolescents. Journal of the American Medical Association, 289, 1813-1819.

Singer, J.D. (1998). Using SAS PROC MIXED to fit multilevel models, hierarchical models, and individual growth models. Journal of Educational and Behavioral Statistics, 24(4), 323-355.

Strauss, R. S. and Pollack, H. A. (2003). Social marginalization of overweight children. Archives of Pediatric and Adolescent Medicine, 157, 746 – 752.

United States Department of Agriculture. (September, 2000). *Food and Nutrition Service (FNS) Strategic Plan 2000 to 2005*. Washington, DC: Author.

U.S. Department of Health and Human Services. *Healthy People 2010*. 2nd ed. With Understanding and Improving Health and Objectives for Improving Health. 2 vols. Washington, DC: U.S. Government Printing Office, November 2000.

Washington State University. *Eat Better, Eat Together*. Accessed October 16, 2007 at: http://nutrition.wsu.edu/ebet/index.html.

Table 1. Characteristics of Children and Families at Kindergarten Fall (n = 8,459)[a]

	Mean	+SD	Range
Child Age (months)	68.42	4.05	51.13 – 86.23
Siblings	1.43	1.11	0 – 10
Median Annual Income (dollars)	$ 48,000		0 – $ 999,999

	N (%)

Child Gender
Boys (= 0)   4080 (48)
Girls (= 1)   4379 (52)

Child Race
White/Non-Hispanic   5296 (63)
African-American   874 (10)
Hispanic   1376 (16)
Asian   440 (5)
Native Hawaiian / Pacific Islander   129 (2)
American Indian or Alaska Native   114 (1)
Multi-Race (Non-Hispanic)   221 (3)

Family Type
2 Parents + Siblings   6033 (71)
2 Parents No Siblings   836 (10)
1 Parent + Siblings   1030 (12)
1 Parent No Siblings   486 (6)
Other   74 (<1)

Home Language (n=8,456)
Non-English   1002 (12)
English   7454 (88)

Table 1. (continued)

	N (%)
Maternal Education (n=8,374)	
8th Grade or below	296 (4)
9th to 12th Grade	526 (6)
High School Diploma	2470 (30)
Vocational Program	460 (5)
Some College	2317 (28)
Bachelor's Degree	1535 (18)
Graduate or Professional (no degree)	187 (2)
Master's Degree	431 (5)
Doctorate or Professional Degree	152 (2)
SES Categorical Measure[b]	
1st Quintile (lowest)	1126 (13)
2nd Quintile	1523 (18)
3rd Quintile	1763 (21)
4th Quintile	1907 (23)
5th Quintile (highest)	2140 (25)
Poverty Level	
Below Poverty	1225 (14)
Above Poverty	7234 (86)

[a] Values are unweighted.

[b] Family socioeconomic status is represented by a composite variable which uses kindergarten spring parent interview data, specifically maternal/female education and occupation, paternal/male education and occupation, and household income (see United States Department of Education, National Center for Education Statistics, 2001 for more details).

Table 2. Study 1: Prevalence of Child Overweight[a]: Within-Time and Longitudinally (n = 8,459)

	K-Fall	K-Spring	1st-Spring	3rd-Spring
Within-Time Overweight	999 (12)	943 (11)	1,118 (13)	1,527 (18)

Longitudinal Overweight

Never Overweight (n = 6643; 79%)	No	No	No	No

Intermittently Overweight (n = 459; 5%)

	K-Fall	K-Spring	1st-Spring	3rd-Spring
n=83	Yes	No	No	No
n=51	No	Yes	No	No
n=56	No	No	Yes	No
n=37	Yes	Yes	No	No
n=16	Yes	No	Yes	No
n=54	Yes	No	No	Yes
n=11	No	Yes	Yes	No
n=35	Yes	Yes	Yes	No
n=52	Yes	Yes	No	Yes
n=64	Yes	No	Yes	Yes

Early and Persistent Overweight (n= 1,357; 16%)

	K-Fall	K-Spring	1st-Spring	3rd-Spring
n = 421	No	No	No	Yes
n = 179	No	No	Yes	Yes
n = 99	No	Yes	Yes	Yes
n = 658	Yes	Yes	Yes	Yes

[a] Children were categorized as overweight or not overweight on the basis of their Body Mass Index (BMI; child weight in kilograms divided by height in meters squared) as not overweight ($<$ 95th percentile) or overweight ($\geq$ 95th percentile) (Kuczmarski, Ogden, Guo et al., 2002).

Table 3. Study 2: Mean Body Mass Index Percentiles (and standard deviations) for Overweight Groups by Time (n = 8,000)[a]

	K-Fall	K-Spring	1st-Spring	3rd-Spring
Kindergarten Group (n = 757)	96.34 (10.04)	98.24 (1.34)	98.34 (1.16)	98.43 (1.03)
First Grade Group (n = 179)	85.56 (12.89)	86.79 (11.62)	96.61 (1.08)	97.62 (1.03)
Third Grade Group (n = 421)	78.29 (18.30)	79.26 (16.97)	85.15 (13.73)	96.60 (1.10)
Never Overweight (n = 6,643)	54.55 (26.24)	54.08 (25.59)	53.27 (25.76)	56.44 (26.63)

[a] Children who became overweight at kindergarten fall or spring and were overweight at first and third grade were members of the *kindergarten* group (n = 757); children who were not overweight during kindergarten but who became overweight by first grade spring and remained overweight at third grade spring comprised the *first grade* group (n = 179); and, children who were not overweight during kindergarten and first grade and who became overweight by third grade spring made up the *third grade* group (n = 421). Children who were not overweight at any of the 4 time points comprised the *never overweight* group (n = 6,643).

Table 4. Multilevel Logistic Regression Results: Univariate Associations between Correlates and Childhood Overweight[a]

	γ	SE	OR
Child Participation in WIC	.26***	.07	1.30
Child Participation in School Breakfast	.10	.08	1.10
Child Participation in Free/Reduced Lunch	.20*	.08	1.22
Household Receipt of Food Stamps	.05	.06	1.05
Child TV Hours/Week (Mean of K, 1, 3)	.03#	.004	1.03
Child Aerobic Exercise/Week (Mean of K, 3)	-.03	.02	1.03
Child Opps. for Exercise (Mean of K, 3)	-.02	.03	1.02
Family Meals/Week (Mean of K, 1, 3)	-.08#	.01	1.09
Neighborhood Safety (Mean of K, 1, 3)	-.23**	.07	1.27

[a] All univariate analyses accounted for child and family demographic covariates.

* $p < .05$; ** $p < .01$; *** $p < .001$; # $p < .0001$

Table 5. Multilevel Logistic Regression Results: Multivariate Associations between Correlates[a] and Childhood Overweight (n = 7,921)

	γ	SE	OR
Intercept	-.36	.26	
Child TV Hours/Week (Mean of K, 1, 3)	.03#	.004	1.03
Family Meals/Week (Mean of K, 1, 3)	-.08#	.01	1.09
Neighborhood Safety (Mean of K, 1, 3)	-.19*	.08	1.20
Child Gender (0 = boy)	-.14	.07	1.15
Child Race[b]			
African American	-.22	.14	1.25
Hispanic	.52#	.11	1.68
Asian	.56*	.26	1.75
Pacific Islander	.19	.36	1.21
American Indian	.90***	.24	2.46
Multi-Race	.04	.21	1.04
Family SES	-.13#	.02	1.14
Gender x African American	62***	.17	1.86
Gender x Hispanic	-.37*	.15	1.45
Gender x Asian	-1.35**	.48	3.85
Variance Components			
School Level	.42#	.05	
Child	.87#	.01	

[a] Child participation in WIC and the Free/Reduced Lunch program became non-significant when included in the multivariate analyses.

[b] Comparison group is White/Non-Hispanic.

* p < .05; ** p < .01; *** p < .001; # p < .0001

Table 6. Multilevel Individual Growth Models of Child Academic Achievement: Direct Assessments (Standard Errors in Parentheses)

| | Direct Assessments | |
	Reading	Math
Fixed Effects		
Intercept	16.80 (0.34)***	18.19 (0.24)***
Time	21.71 (0.16)***	14.29 (0.11)***
Time * Time	0.94 (0.04)***	1.34 (0.03)***
Overweight Group[a]		
Overall F	0.40	1.46 (0.22)
Kindergarten	−0.32 (0.32)	-0.38 (0.22)
First Grade	0.20 (0.63)	-0.49 (0.43)
Third Grade	0.07 (0.42)	-0.24 (0.29)
Overweight Group * Time		
Overall F	3.92**	4.93**
Kindergarten	-0.36 (0.16)*	-0.37 (0.13)**
First Grade	-0.73 (0.32)*	-0.65 (0.25)**
Third Grade	-0.36 (0.21)	-0.12 (0.16)
Gender	1.17 (0.18)***	-0.16 (0.13)
Child Race[b]		
African-American	−1.51 (0.35)***	-1.87 (0.25)***
Hispanic	−2.58 (0.31)***	-2.77 (0.21)***
Asian	2.75 (0.49)***	-0.15 (0.36)
Pacific Islander	−2.07 (0.93)*	-2.78 (0.67)***
American Indian	−3.07 (0.90)***	-1.23 (0.64)
Multi-Race	−0.26 (0.58)	−1.10 (0.42)**
Family SES	2.09 (0.08)***	1.19 (0.06)***

Table 6. (continued)

	Direct Assessments	
	Reading	Math
Variance Components		
School		
Initial Status	8.10 (0.81)***	5.80 (0.56)***
Linear Trend	10.72 (1.07)***	4.00 (0.44)***
Quadratic Trend	0.77 (0.08)***	0.50 (0.05)***
Child (within school)		
Initial Status	46.85 (1.13)***	31.01 (0.71)***
Linear Trend	38.09 (1.37)***	12.28 (0.60)***
Quadratic Trend	3.03 (0.10)***	1.56 (0.06)***
Time (within child)	18.20 (0.25)***	11.58 (0.15)***

[a] Comparison Group is Never Overweight.
[b] Comparison Group is White/Non-Hispanic.
* $p < .05$; ** $p < .01$; *** $p < .001$

Table 7. Multilevel Individual Growth Models of Teacher Reports of Child Social-Emotional Well-Being (Standard Errors in Parentheses)

	Learning	Self-Control	Interpersonal Skills	Externalizing Behaviors	Internalizing Behaviors
Fixed Effects					
Intercept	2.79***	2.96***	2.82***	1.77***	1.61***
	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)
Time	0.06***	0.08***	0.13***	0.04***	0.05***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Time*Time	-0.02***	-0.02***	-0.03***	-0.003	-0.01*
	(0.003)	(0.003)	(0.003)	(0.002)	(0.003)
Overweight Group[a]					
Overall F	4.86**	0.16	0.95	1.59	1.82
Kindergarten	-0.05**	-0.01	-0.03	0.06*	0.03
	(0.02)	(0.02)	(0.03)	(0.03)	(0.02)
First Grade	-0.06	-0.01	-0.04	-0.02	0.05
	(0.04)	(0.05)	(0.05)	(0.06)	(0.04)
Third Grade	-0.06**	0.02	0.03	-0.02	0.03
	(0.02)	(0.03)	(0.03)	(0.04)	(0.02)
Gender	0.25***	0.20***	0.23***	-0.23***	-0.02**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Overweight Group * Time					
Overall F	-	-	3.87**	4.67**	-
Kindergarten	-	-	0.02*	-0.04***	-
			(0.01)	(0.01)	
First Grade	-	-	-0.03*	-0.01	-
			(0.02)	(0.02)	
Third Grade	-	-	-0.01	-0.01	-
			(0.01)	(0.01)	

Table 7. (continued)

	Learning	Self-Control	Interpersonal Skills	Externalizing Behaviors	Internalizing Behaviors
Overweight Group * Gender					
Overall F	-	5.02**	3.77*	0.86	2.98*
Kindergarten	-	-0.05*	-0.06	-0.01	0.07**
		(0.03)	(0.03)	(0.04)	(0.03)
First Grade	-	-0.06	0.02	0.05	-0.07
		(0.06)	(0.07)	(0.08)	(0.05)
Third Grade	-	-0.15***	-0.12**	0.08	0.00
		(0.04)	(0.04)	(0.05)	(0.03)
Time * Gender	-	-	-	-0.01*	-
				(0.00)	
Overweight Group * Time * Gender					
Overall F	-	-	-	3.24*	-
Kindergarten	-	-	-	0.04*	-
				(0.01)	
First Grade	-	-	-	0.03	-
				(0.03)	
Third Grade	-	-	-	0.04	-
				(0.02)	
Child Race[b]					
African-American	−0.14***	-0.20***	-0.14***	0.20***	0.02
	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)
Hispanic	−0.03	−0.01	−0.01	−0.03	-0.03*
	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)
Asian	0.16***	0.10***	0.05	−0.15***	-0.09***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.02)

Table 7. (continued)

	Learning	Self-Control	Interpersonal Skills	Externalizing Behaviors	Internalizing Behaviors
Pacific Islander	−0.16**	-0.16***	-0.21***	0.14**	0.03
	(0.05)	(0.05)	(0.05)	(0.05)	(0.04)
American Indian	0.01	−0.05	−0.05	0.06	0.02
	(0.05)	(0.04)	(0.05)	(0.05)	(0.04)
Multi-Race	−0.02	0.003	−0.02	−0.01	0.03
	(0.04)	(0.03)	(0.03)	(0.03)	(0.03)
Family SES	0.07***	0.04***	0.05***	-0.03***	-0.03***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)

Variance Components

Teacher

	Learning	Self-Control	Interpersonal Skills	Externalizing Behaviors	Internalizing Behaviors
Initial Status	0.10***	0.11***	0.11***	0.05***	0.07***
	(0.006)	(0.006)	(0.01)	(0.004)	(0.004)
Linear Trend	0.12***	0.12***	0.14***	0.06***	0.07***
	(0.008)	(0.01)	(0.01)	(0.006)	(0.006)
Quadratic Trend	0.006***	0.007***	0.008***	0.004***	0.004***
	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)

Child (within teacher)

	Learning	Self-Control	Interpersonal Skills	Externalizing Behaviors	Internalizing Behaviors
Initial Status	0.17***	0.14***	0.14***	0.20***	0.11***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.004)
Linear Trend	0.15***	0.14***	0.15***	0.12***	0.16***
	(0.008)	(0.01)	(0.009)	(0.01)	(0.007)
Quadratic Trend	0.009***	0.01***	0.01***	0.01***	0.01***
	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)

Table 7. (continued)

	Learning	Self-Control	Interpersonal Skills	Externalizing Behaviors	Internalizing Behaviors
Time (within child)	0.11*** (0.001)	0.11*** (0.001)	0.13*** (0.002)	0.09*** (0.001)	0.09*** (0.001)

[a] Comparison Group is Never Overweight.
[b] Comparison Group is White/Non-Hispanic.
* *p* < .05; ** *p* < .01; *** *p* < .001

Table 8. Multilevel Random Coefficient Models of Child Self-Description Questionnaire (3rd Grade Spring) (Standard Errors in Parentheses)

	Reading	Math	All Subjects	Interpersonal Skills	Externalizing Behaviors	Internalizing Behaviors
Fixed Effects						
Intercept	3.11***	3.22***	2.86***	2.98***	2.27***	2.37***
	(0.03)	(0.03)	(0.03)	(0.02)	(0.03)	(0.03)
Overweight Group[a]						
Overall F	3.26*	1.37	0.71	6.91***	0.97	4.08**
Kindergarten	-0.03	0.03	-0.02	-0.07**	0.00	0.07**
	(0.03)	(0.03)	(0.02)	(0.02)	(0.02)	(0.03)
First Grade	-0.05	0.08	-0.01	-0.11*	0.08	0.11*
	(0.07)	(0.06)	(0.05)	(0.05)	(0.05)	(0.05)
Third Grade	-0.13**	0.04	-0.04	-0.09**	0.01	0.03
	(0.04)	0.04	(0.03)	(0.03)	(0.03)	(0.03)
Gender	0.17***	-0.20***	0.06***	0.08***	-0.19***	0.04**
	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
Overweight Group * Gender						
Overall F	3.42*	-	-	-	-	-
Kindergarten	-0.07	-	-	-	-	-
	(0.05)					
First Grade	0.16	-	-	-	-	-
	(0.09)					
Third Grade	0.13*	-	-	-	-	-
	(0.06)					

Table 8. (continued)

	Reading	Math	All Subjects	Interpersonal Skills	Externalizing Behaviors	Internalizing Behaviors
Child Race[b]						
African-American	0.04	0.05	0.04*	0.07*	0.24***	0.24***
	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)	(0.03)
Hispanic	0.04	0.04	0.04	-0.01	0.02	0.15***
	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)
Asian	0.03	0.15*	0.08	-0.18***	-0.12*	0.02
	(0.05)	(0.06)	(0.05)	(0.05)	(0.05)	(0.05)
Pacific Islander	0.08	-0.02	0.04	–0.09	0.31**	0.19
	(0.09)	(0.12)	(0.09)	(0.09)	(0.09)	(0.10)
American Indian	0.04	-0.02	-0.06	–0.02	0.00	0.00
	(0.07)	(0.09)	(0.07)	(0.07)	(0.07)	(0.08)
Multi-Race	0.02	0.06	0.08	-0.02	0.05	0.03
	(0.05)	(0.06)	(0.05)	(0.05)	(0.05)	(0.05)
Family SES	0.02***	-0.00	0.01	0.01	-0.08***	-0.10***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Variance Components						
Teacher	0.11***	0.14***	0.11***	0.09***	0.10***	0.10***
	(0.007)	(0.01)	(0.008)	(0.006)	(0.007)	(0.008)
Child	0.33***	0.49***	0.33***	0.32***	0.33***	0.37***
	(0.006)	(0.009)	(0.006)	(0.005)	(0.006)	(0.007)

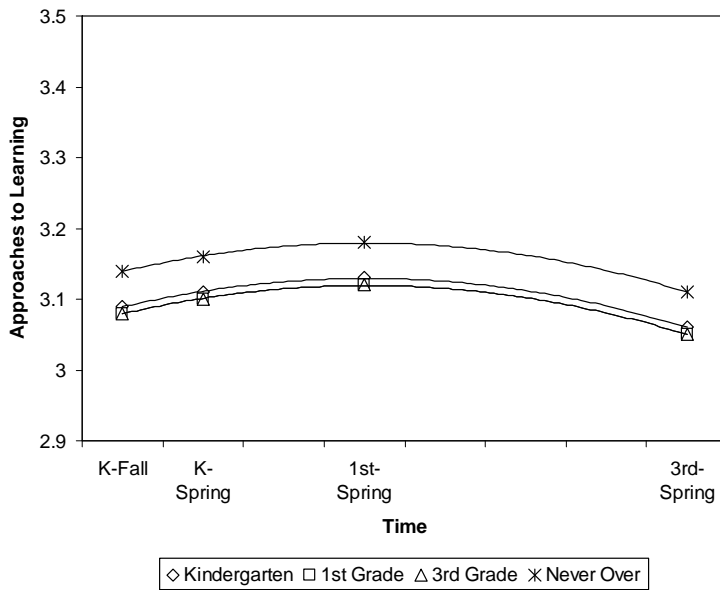[a] Comparison Group is Never Overweight.
[b] Comparison Group is White/Non-Hispanic.
* $p < .05$; ** $p < .01$; *** $p < .001$

Figure 1. Teacher ratings of children's approaches to learning at each time point for all overweight groups.

Child Approaches to Learning

Overweight (F = 4.86**)

BOYS and GIRLS
K: γ = -0.05**
3rd: γ = -0.06**

Cohen's d: 0.09 – 0.11

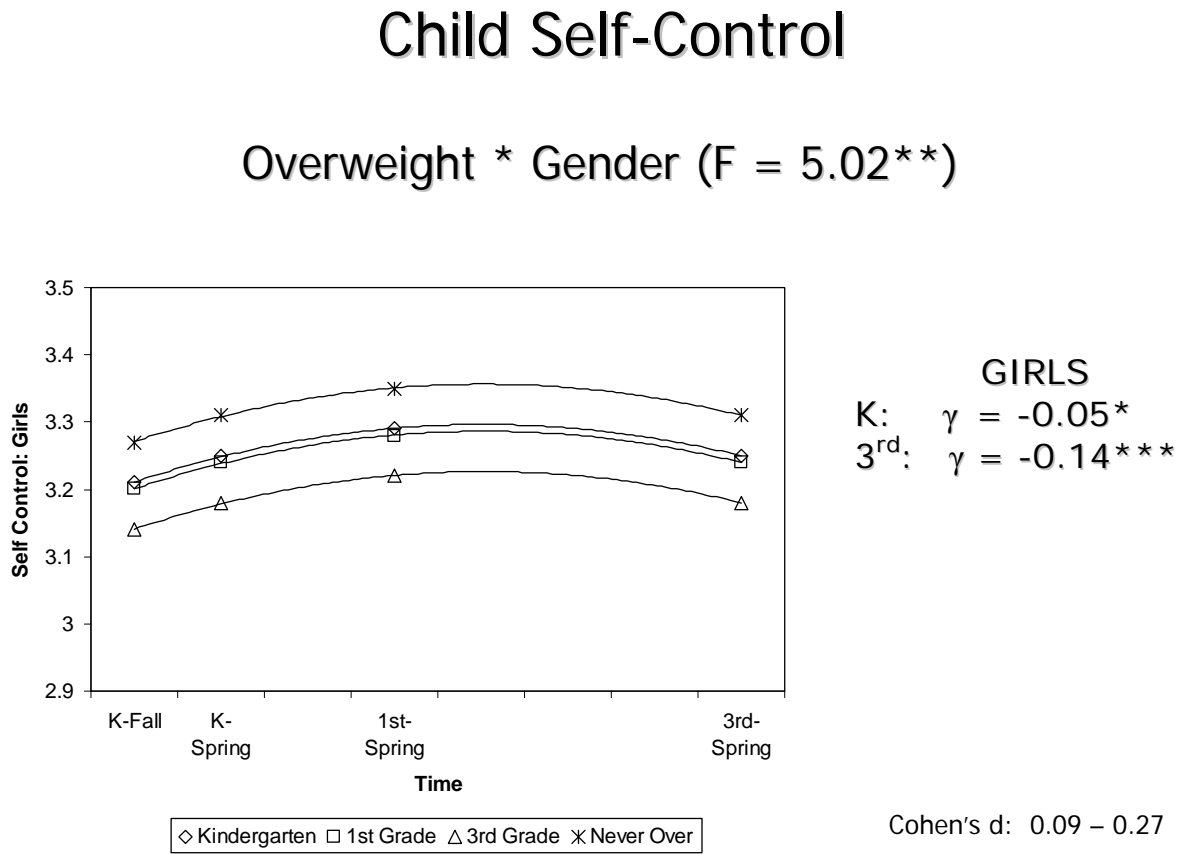**Figure 2.** Teacher ratings of girls' self-control at each time point for all overweight groups.

Child Self-Control

Overweight * Gender (F = 5.02**)

GIRLS
K: γ = -0.05*
3rd: γ = -0.14***
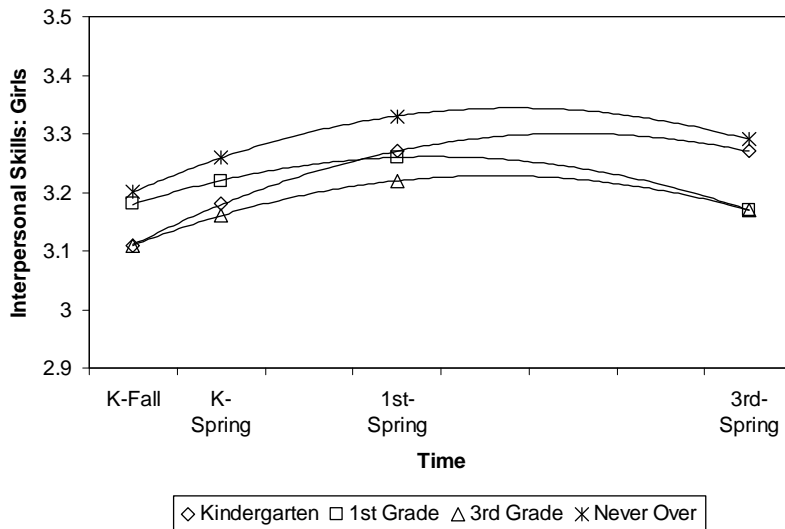
Cohen's d: 0.09 – 0.27

Figure 3. Teacher ratings of girls' interpersonal skills at each time point for all overweight groups.

Child Interpersonal Skills

Overweight * Time (F = 3.87*)
Overweight * Gender (F = 5.02**)

GIRLS
K: Effects at kindergarten and 1st grade; disappear by 3rd grade
3rd: Effects persist from kindergarten entry until 3rd grade

Cohen's d: 0.12 – 0.25

Figure 4. Teacher ratings of child externalizing behaviors at each time point for all overweight groups.

Child Externalizing Behaviors
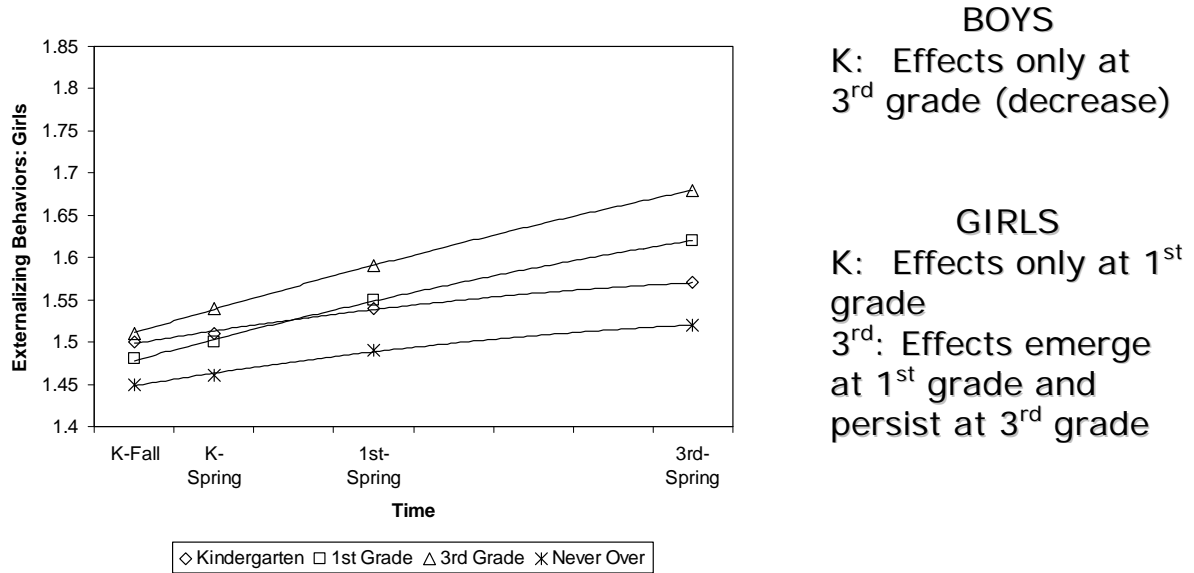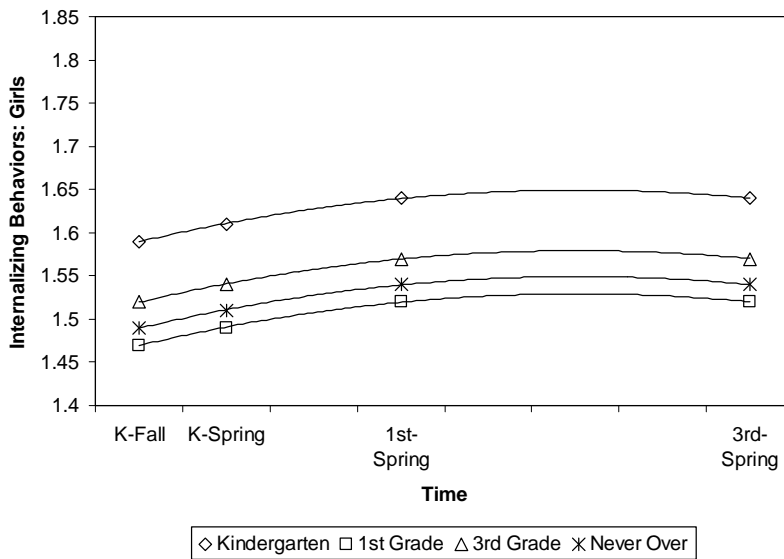
Overweight * Time * Gender (F = 3.24*)

BOYS
K: Effects only at
3rd grade (decrease)

GIRLS
K: Effects only at 1st grade
3rd: Effects emerge at 1st grade and persist at 3rd grade

Cohen's d: 0.09 – 0.29

Figure 5. Teacher ratings of girls' internalizing behaviors at each time point for all overweight groups

Child Internalizing Behaviors

Overweight * Gender (F = 2.98*)

GIRLS
K: γ = 0.10***

Cohen's d: 0.24

Appendix A. Child Academic Achievement: Unadjusted Means and Standard Deviations by Time and Child Weight Groups [a]

	Kindergarten Overweight (n = 757) Mean (SD)	1st Grade Overweight (n = 179) Mean (SD)	3rd Grade Overweight (n = 421) Mean (SD)	Never Overweight (n = 6,643) Mean (SD)
Direct Assessments of Child:				
Reading				
Kindergarten Fall	22.05 (7.58)	23.17 (7.82)	22.24 (7.86)	23.93 (8.74)
Kindergarten Spring	32.54 (9.31)	32.65 (9.57)	32.90 (9.46)	34.40 (10.01)
1st Grade Spring	56.56 (12.30)	56.03 (12.15)	56.56 (12.30)	59.24 (12.05)
3rd Grade Spring	108.12 (18.87)	108.94 (17.91)	108.70 (18.58)	112.19 (17.68)
Math				
Kindergarten Fall	19.52 (6.58)	20.17 (6.74)	19.64 (7.03)	21.18 (7.48)
Kindergarten Spring	27.85 (8.03)	27.78 (7.84)	28.26 (8.35)	29.76 (8.54)
1st Grade Spring	43.52 (8.08)	43.21 (7.68)	44.10 (8.16)	45.70 (7.93)
3rd Grade Spring	85.13 (16.42)	84.65 (16.58)	85.64 (17.04)	88.38 (16.16)

[a] Values are unweighted.