The Effect of Summer Break Length and Structured Summertime Activities on Overweight Status of Children

by

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Certificate of Approval

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TABLE OF CONTENTES

List of Tables

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Abstract

Background: The prevalence of overweight children is rapidly increasing in the United States, causing some to label it as an "epidemic" (Hill, 2006). Many studies have explored the relationship between risk factors such as physical activity and overweight status in children. However, few studies have investigated the relationship between structured activities and children's overweight status. A recent study by von Hippel et al. (2007) has shown that children's Body Mass Index (BMI) increased at a greater rate during the summer break months than during the months the children were in school, suggesting that structured activities may play a role in determining overweight status in children.

Objectives: This study hopes to elucidate patterns of weight-gain in children by exploring the relationship between children's weight status, measured by body mass index, and the duration of summer break and the duration and types of structured activities.

Methods: This study employs a secondary data analysis of the Early Childhood Longitudinal Study-Kindergarten Cohort data set (US Dept. of Ed., NCES, 2004). It assesses the potential association between the length of summer break from school, as well as structured non-school summertime activities of children and overweight status of children (defined as children whose body mass index exceeds the 95th percentile on the CDC's clinical growth charts for children age 2-20 years (Kuczmarski et al, 2000)).

Results: The odds of being overweight in third grade for children who had a summer break length of 85-89 days were 0.53 (95% CI: 0.30-0.97) times the odds of being overweight in third grade for children in the reference group (summer break length

≤74 days). No statistically significant differences were found between the reference category and other summer break length categories. No statistically significant differences were found between varying types of activity participation. However, other covariates showed statistically significant odds of predicting overweight status in third grade: African-American children (compared to white, non-Hispanic), OR=1.97 (95% CI=1.32-2.94); and highest socio-economic status (SES) category (compared to lowest), OR=0.51 (95% CI=0.30-0.89). Further, interaction between kindergarten overweight status and gender caused different odds of third grade overweight status: the odds of being overweight in third grade for females who were overweight in kindergarten were 113.7 times the odds of being overweight in third grade for females who were not overweight in kindergarten ($p<0.0001$); the odds of being overweight in third grade for males who were overweight in kindergarten were 51.6 times the odds of being overweight in third grade for males who were not overweight in kindergarten ($p<0.0001$).

Conclusions: Despite statistically significant differences in third grade overweight status among different summer break lengths, no consistent pattern exists. Further, evaluation of structured summertime activities generated no statistically significant results. Although conclusions about this relationship cannot be drawn from these analyses, the associations of summer break length and structured summertime activities with overweight status in children cannot be overlooked. More detailed analyses are necessary to further elucidate these relationships. Further, interaction between gender and previous overweight status suggests differences in weight gain patterns between males and females.

Introduction

Background and Significance

Much is written about the trend of increasing obesity in America. Obesity in adults is defined by BMI in kg/m^2 greater than or equal to 30; while overweight status is defined as those adults whose BMI is greater than or equal to 25 but less than 30. It is estimated that the age-adjusted prevalence of obesity in the United States increased from 22.9% during the NHANES III survey years of 1988-1994 to 30.5% in 1999-2000. Prevalence of overweight adults also increased in the time between these two measurements, from 55.9% to 64.5% (p-value <0.001) (Flegal et al, 2002). The large and widespread increase in obesity has led some to refer to this phenomenon as an 'epidemic' (Hill, 2006). No demographic group has been insulated from the epidemic as increases have been measured in many demographic groups (Flegal et al, 2002).

The value in addressing the epidemic of obesity in the US is great, as it has been linked to numerous health burdens. About 300,000 annual deaths are attributable to obesity (Allison et al, 1999). The risk of developing chronic diseases such as Type II Diabetes is increased in the obese (Mokdad et al, 2003). Further, obese people show increased risk of developing hypercholesterolemia, asthma, arthritis, poor health status (Mokdad et al, 2003), colon cancer (Giovannucci, 1995) and cardiovascular disease (Kannel et al, 1991). The increase of chronic diseases and other negative health outcomes exacerbated by obesity places increased burden on the US health care system. Currently, obesity accounts for approximately 6% of all health care expenditures in the US (Andreyeva et al, 2004). The high costs that the obesity epidemic has on the health of people in the US and the US health care system provide an incentive for timely management.

Increasing obesity prevalence also has been observed in children. Obesity is defined differently in children than in adults. Overweight status is defined (Himes et al, 1994) as children whose BMI falls at or above the 95th percentile on the CDC's sex-specific clinical growth charts (Kuczmarski et al, 2000) for children age 2-20 years, while those 'at risk of being overweight' (Himes et al, 1994) are children whose BMI falls at or above the 85th percentile but below the 95th percentile on the CDC's sex-specific clinical growth charts (Kuczmarski et al, 2000). Troiano and Flegal (1998) showed increases in overweight status of children across different demographic categories in cross-sectional analyses of NHES and NHANES data sets (Troiano et al, 1998). More recent analyses by Ogden et al. (2006) show statistically significant ($p<0.05$) increases in overweight status of male adolescents from 14.0% to 18.2% and of female adolescents from 13.8% to 16.0% in a study comparing data from 1999-2000 to data from 2003-2004 (Ogden et al, 2006), although the trend has most recently leveled off (Ogden et al, 2008). Coupled with children's increasing weight status is evidence that children who are classified as overweight are more likely to become obese adults (Ferraro et al, 2003). Children who were overweight between the ages of 2 and 5 were shown to be more than 4 times as likely to be obese in adulthood (Freedman et al, 2005). As overweight children grow into obese adults, the burdens on their health and on the US health care system will increase correspondingly.

Several factors that influence the risk of overweight in children have been established. Decreased physical activity, increased television watching, and low meal frequencies are all predictors of overweight in children (Toschke et al, 2007). Other risk factors include eating fast-food and energy-dense convenience food, decreased parental support (von Hippel et al, 2007), and built environment shortcomings such as lack of sidewalks and recreation centers (Gordon-Larsen et al, 2006). Risk factors are present year-round. However, during the summer, consistent exposure to the risk factors may increase with the disappearance of the mandatory structured environment offered by school.

Summer break and its lack of structured environment offer a ripe opportunity for children to neglect behaviors learned during the school year. A study by von Hippel et al (2007) analyzed growth rates in children during the school year and during summer break. The authors showed that children's BMI increased at a greater rate over the summer break months than during the months the children were in school. Similar efforts have been made to study weight gain patterns in adults. A study by Haines et al (2003) demonstrated that adults gain weight more quickly over the weekend and during the winter holidays, periods of time when they break from their routine, structured environments. Similarly, summer break from school is a break from a child's structured environment. Consequently a child's opportunity to gain weight has the potential to increase.

Overweight prevention strategies require comprehensively understanding different causes of overweight status in children. Currently, environmental factors are driving the obesity epidemic (Jeffery and Utter, 2003). Hence, it is important that such factors as length of summer break and quantity of summertime activities continue to be examined to deepen this understanding. Many overweight prevention strategies aimed at school-aged children incorporate some sort of physical activity.

However, few of these strategies recognize the structure underlying the activity as a possible mechanism of healthy weight maintenance. To increase understanding of the roles that structured activities have in weight-gain patterns in children, this study assesses the potential association with the change in structured environments that occurs during summer break by assessing the relationship between summer break length and overweight status in children (determined as exceeding the 95^{th} percentile of body mass index on the CDC's clinical growth charts for children age 2-20 years (Kuczmarski et al, 2000)). It uses data collected by the Early Childhood Longitudinal Study – Kindergarten Cohort (ECLS-K) (US Dept. of Ed., NCES, 2004). To further analyze the amount of structure in a child's life, this study assesses structured physical and non-physical activities in which children participated during the summer. The main objective of this study is to evaluate differences in summer break lengths and exposure to structured summertime activities among children in different weight categories.

Research Question and Specific Aims

This study seeks to answer the following question: Are the length of summer break and participation in structured non-school summer activities predictive of weight status in younger children? This study has two major objectives:

1) To test the hypothesis that overweight children in the third grade are more likely to have had longer summer breaks than those children who are not overweight.

2) To test the hypothesis that overweight children in the third grade are less likely to have participated in summertime activities than those children who are not overweight, by examining:
    a. Attendance of summer camps or participation in other structured activities,
    b. Duration of participation in camps or other structured activities, and
    c. Number of summertime activities.

Testing these hypotheses will be achieved by using the ECLS-K dataset to accomplish the following specific aims:

1) Obtain the composite body mass index variable for children at kindergarten, first grade, and third grade time points.
2) Determine the length of summer break and use it as a predictor variable in a statistical model that assesses the association between summer break length and overweight status of children, as measured by body mass index (BMI).
3) Classify the types of activities during summer break into participation in physical activities, non-physical activities, both physical and non-physical activities, or no activities and determine the length of time spent engaged in non-school-sponsored camp and tutoring activities, classifying them as time spent participating in physical or non-physical activities.
4) a. Model the statistical association between attendance in non-school-sponsored camp and tutoring activities during the summer and overweight status, as measured by BMI.

b. Model the statistical association between length of time each child spent engaged in camp, tutoring, and other structured activities during the summer and overweight status, as measured by BMI.

c. Measure the effect that increasing quantity of structured activities has on overweight status, as measured by BMI.

Methods

Study Participants

The Early Childhood Longitudinal Study, Kindergarten Cohort (ECLS-K) surveys a nationally representative sample of children across their progression in school. The children were chosen as part of a multi-stage probability sampling design. Data collected during the kindergarten year serve as baseline measurements, with subsequent data collection in first, third, fifth, and eighth grades. The baseline collection consisted of 21,260 kindergartners from 1,280 schools (US Dept. of Ed., NCES, 2004).

This study used data collected during fall and spring collections in kindergarten and first grade, and spring collection of third grade. In order to focus on the study's hypotheses, I applied inclusion criteria to narrow the ECLS-K dataset. First a dataset was created using the ECLS-K Third Grade Public-Use Data File, which contained 17,401 subjects. Second, I excluded children who attended a year-round school (n=530), who did not have BMI measurements at baseline (n=295) and during third grade (n=3683), for whom summer break length could not be calculated (n=4252), and who did not answer questions pertaining to summertime activity. I reduced the dataset to children who had information about each additional variable that I wanted to evaluate – race, gender, socio-economic status (SES), and kindergarten overweight status – reducing the number of participants to 3,078. The study was submitted for review by the Institutional Review Board of Oregon Health & Science University, which gave the study exempt status.

Measures

Overweight Status

ECLS-K measured children's height and weight at each data collection period. With these measurements, they calculated raw BMI scores. I determined overweight status by first converting the raw BMI scores into BMI-for-age Z-scores, using data collected during the third-grade time period. If a child's BMI-for-age Z-score fell at or above the 95th percentile on the CDC's sex-specific clinical growth charts (Kuczmarski et al, 2000) for children age 2-20 years, that child was assigned into the "overweight" category (following conventional usage of the term overweight); a child with a BMI Z-score below the 95th percentile was classified as "not overweight."

To calculate sex-specific BMI-for-age Z-score, I used the following formula given by the CDC and the NCHS: $Z = \frac{\left(X/M\right)^{L} - 1}{LS}$, where X is the calculated BMI (based on physical measurements of the child), and L, M, and S are age-specific values contained in the BMI-for-age chart provided by the CDC. Because age (in months) was estimated as a range during the third grade data collection, the midpoint of the age range was selected to represent that child's age. For example, in the age range 114 to <117 months, the value 115.5 was chosen. For those who were less than 105 months old, the value 104.5 months was chosen. For those 117 months or greater, the value of 117.5 months was chosen. I also evaluated the Z-scores when a low value of 103.5 and an upper value of 118.5 were chosen (each 1.5 months different than the cutoff points). There was no difference in Z-scores for these cutoff choices. BMI-for-age Z-scores were calculated from measurements during kindergarten for use as a covariate. More precise age measurements were gathered by ECLS-K during the kindergarten, allowing a more precise calculation of BMI-for-age Z-score.

Summer Break Length

To estimate summer break length, I used information about the beginning and ending dates of the cohort's first grade school year. I used these data because they were the only collected data that were available for estimating the length of summer break. The dates were transformed into a value with days as the units. The ending day was subtracted from the beginning day, giving a value that represents the length (in days) of summer break.

The distribution of summer break lengths among children without missing data was approximately normal. For the purpose of this analysis, the summer break length was separated into 5 categories. The decision to separate the continuous variable into a multi-level categorical variable was due to its lack of linearity in the logit function. Category designation was based on five-day intervals (except for the reference category) to represent interpretable categories.

Summer Break Activities

Calculation of participation in summertime activities used responses to questions in the ECLS-K about participation in summer camp, non-school sponsored tutoring, and other summer activities (Table 1). ECLS-K asked these questions during spring of the first grade year; the answers therefore correspond to activities during the summer between kindergarten and first grade. I separated activities into physical activity (PA), non-physical activity (NPA), or both (as in the case of camp participation). Therefore, a child's participation in structured summertime activities could be classified as either physical or non-physical activities, or both.

To test Study Objective #2a, a multi-level variable was created that reflects participation (0=no participation in any activities, 1=participation in PA only, 2=participation in NPA only, and 3=participation in both). Participation in camp counted as one activity, and could have been classified as PA, NPA, or both, depending on the activities that the camp offered. In total, there were a possible five PA's and four NPA's in which a child could participate.

To quantify duration of participation, Study Objective #2b, I used responses to questions asked by ECLS-K about time spent at summer camps and with a tutor during the summer. Responses were gathered in three formats: hours per day, days per week, and number of weeks. By multiplying hours by days by weeks, the total time in hours spent in such activities was calculated. Similar to the number of activities, the amount of time participating in activities was separated into PA, NPA, and both.

To test Study Objective #2c and to quantify the amount of structured activities, two other variables were created that assessed the number of PA's and NPA's in which a child participated. The number of PA's and NPA's were added for each of the variables. The type of activity at camp was added to the appropriate one of these variables, depending on what that child did. If the child participated in both physical and non-physical activities at camp, it was recorded as an activity in each of the PA and NPA variables.

ECLS-K Question	Type of Activity	Final Activity Categorization	
Did Child attend any day or overnight camps over the summer?		Activity	Type
Did the camp include...			
Sports?	PA	Camp	Either PA, NPA, or Both
Arts and Crafts?	NPA		
Field trips?	NPA		
Games?	PA		
Nature lessons or science?	NPA		
Other academic lessons?	NPA		
Music?	NPA		
Performing arts or drama?	NPA		
Computers?	NPA		
Was child tutored over the summer on a regular basis, by someone other than you or a family member, in a specific subject, such as reading, math, science, or a foreign language?	NPA	Tutor	NPA
Did child participate in any of the following activities during the summer that were not school sponsored, not part of camp or child care, or not provided by a family member...			
Music lessons?	NPA	Music	NPA
Dance lessons?	PA	Dance	PA
Swimming lessons or swim team?	PA	Swim	PA
Team sports or lessons?	PA	Team Sports	PA
Individual sports lessons?	PA	Ind. Sports	PA
Scout groups?	NPA	Scouts	NPA

Table 1: Survey questions that assess activity participation.

Also, the total number of responses to the activity participation questions was added together to quantify the total number of activities in which a child participated, physical and non-physical. The total number of possible PA in which a child could participate was 5 (camp, team and individual sports, and swim and dance lessons), while the total number of possible NPA in which a child could participate was 4 (camp, tutoring, music lessons, and scout group). For this variable, however, camp participation counted as one activity, regardless of the camp-based activities in which a child participated. Therefore this variable had 8 possible activities and not the 9 that would be attained by adding PA and NPA together (Table 1).

Covariate Calculation

ECLS-K calculates a composite variable to represent socio-economic status of its respondents. For each child, the SES of the household in which the child lived was used. ECLS-K calculated this variable using a complex formulation that combined responses to questions that assessed both father/male guardian's and mother/female guardian's education, both father/male guardian's and mother/female guardian's occupation, and the household income level. ECLS-K used imputation strategies to alleviate missing data issues, which are discussed in more detail in the ECLS-K User's Manual (US Dept. of Ed., NCES, 2004). ECLS-K calculated both a continuous and a categorical SES variable for public-use. The categorical variable divided the continuous variable into quintiles. For this study, I used the categorical SES variable. However, by limiting the dataset to children who had information on the variables in which I was interested, the quintiles are not evenly populated. For coding purposes, the categories ranged from the referent category 0, representing the lowest quintile, to 4, representing the highest quintile.

Race was entered into the model as a categorical variable. Those of Hispanic descent were combined into one category whether or not they provided a race when answering the ECLS-K questionnaire. Three categories, American Indian/Alaskan Natives, Native Hawaiian/Other Pacific Islanders, and More than One Race Non-Hispanic were combined to form an “Other” category. White, non-Hispanic children were used as the referent category (0).

Gender was entered into the model as a categorical covariate. Boys were the referent category (0).

Overweight status during kindergarten also was evaluated as a covariate for the logistic regression model. Status was evaluated in the same manner as the outcome variable. BMI-for-age Z-scores were calculated using a chart provided by the CDC. Ages measured by ECLS-K during the kindergarten year were taken in months, with significant figures to the one-hundredth decimal place. This measurement allowed a more precise calculation of the BMI-for-age Z-score than the measurement of the outcome variable.

Other variables that were considered for entry into the logistic regression model included family construction – whether the child lives with two (referent), one, or neither parents; size of town of residence – large and mid size city (referent), large and mid size suburb and large town, and small town and rural; and education level of mother – achieved high school diploma (referent) vs. no HS diploma. However, because ECLS-K included mother’s education level into their calculation of SES, it was removed from consideration as a separate variable.

Regression Model

Procedures

Data from the ECLS-K were used to construct a logistic regression model to evaluate the relationship between length of summer break, structured summertime activities, and overweight status in children. Overweight status, measured during the spring of the third grade year, was used as the outcome variable in the multiple logistic regression model. I used the statistical software package SAS 9.1.3, copyright (c) 2002-2003 by SAS Institute Inc., Cary, NC, USA.

Each predictor variable was evaluated for inclusion into the multivariate logistic regression model by first evaluating its significance in predicting the outcome variable, third grade overweight status, using a univariate model. The initial selection of candidate variables for the multivariate model was based on prior knowledge of the variable's importance in predicting overweight status among children. Of these candidate variables, those that, in Univariate logistic regression, generated p-values of < 0.25 were used to begin the building of the multivariate model. Predictor variables that were of importance to this study were identified *a priori* for inclusion into the model, regardless of the p-value they generated in univariate models. These included variables describing length of summer break and participation in summertime activities.

Variables chosen using the above criteria then were fit into a multivariate model. In this multivariate model, each variable's significance in predicting the outcome was assessed by the p-value it generated. Those with p-values < 0.10 were determined to show adequate predictive strength to remain in the final model. A backward selection technique was used for model building. The variable that generated the highest p-value was removed first, with the exception of variables of *a priori* importance (summer break length and activity participation). A new multivariate model was generated and the procedure was repeated. Variables were removed so that the final model contained only variables with adequate statistical significance (with p-values < 0.10) or *a priori* importance.

Next, interactions between predictor variables were examined. Possible interaction combinations were determined by review of previous literature, as well as possible public health significance such interactions may have. Because previous overweight status is a risk factor for current and future obesity (Ferraro et al, 2003; Freedman et al, 2005), I focused interaction assessment on those between kindergarten overweight status and other covariates. To select the interactions for inclusion into the model, I used similar criteria as described for predictor variable selection by evaluating the variable's statistical significance (p-value < 0.10 for the multivariate model).

Results

Sample Characteristics

Sample characteristics are provided in Tables 2a and 2b. In the sample chosen for inclusion in this study, 11.11% were overweight in third grade. The percentage of overweight children in the sample of children not chosen for this study was 11.22%. These values were not statistically different when compared using a chi-square test (p = 0.7745).

A majority of the children in the study, 62.15%, were white, non-Hispanic. Blacks made up 12.25%, Hispanics made up 13.78%, and those of other racial background made up 11.83%. The race distribution of children included in the study showed a statistically significant difference from the race distribution of children not included in the study ($p < 0.0001$). The excluded children were 56.36% white, non-Hispanic, 12.51% black, 19.06% Hispanic, and 12.06% of other racial background.

Variable	**Category**	**Percent**		Chi-Square p-value
		Included n=3078	Excluded n=14323	
Spring 3rd Grade Overweight Status	Not Overweight	88.89	88.78	
	Overweight	11.11	11.22	0.7745
Race	White	62.15	56.36	
	Black/African-American	12.25	12.51	
	Hispanic	13.78	19.06	
	Other	11.83	12.06	<0.0001
Gender	Female	49.42	49.23	
	Male	50.58	50.77	0.4848
SES	1st (Lowest) Group	13.68	16.89	
	2nd Group	17.97	17.88	
	3rd (Middle) Group	21.02	19.7	
	4th Group	21.67	20.9	
	5th (Highest) Group	25.67	24.63	<0.0001
Town Size	Large and Mid Size City	37.07	38.41	
	Large and Mid Size Suburb and Large Town	38.27	39.65	
	Small Town and Rural	24.66	21.95	<0.0001
Family Construction	Lives with Both parents	78.82	79.21	
	Lives with One parent	19.2	18.93	
	Other living arrangement	1.98	1.87	0.143

Table 2a: Descriptive Statistics

There were slightly more males (50.58%) than females (49.42%). The distribution of gender in the group included in the study was not statistically different from the distribution of the excluded group ($p = 0.4848$).

Children of the highest socio-economic category were the most numerous (25.67%). The amount of children representing each SES category decreased with decreasing group, with the lowest group containing the least children (13.68%). The SES distribution of included children was statistically different from that of excluded children ($p < 0.0001$).

The distribution of town sizes of residence differed significantly between excluded and included children ($p < 0.0001$). Of children included in the study, 38.27% were from large and mid-size suburbs and large towns 37.07% were from large and mid-size cities, and 24.66% were from small towns and rural areas.

Family construction distribution did not differ among included and excluded children. Of children included in the study, 78.82% lived with both parents, 19.2% lived with one parent, and 1.98% had some other living arrangement.

Of children included in the study, 92.85% were not overweight in kindergarten, while 7.15% were overweight. This distribution was not statistically different from excluded children (0.5864).

Of children included in the study, 10.46% had summer break lengths 74 days or less, 35.87% had summer break lengths 75-79 days, 23.94% had summer break lengths 80-84 days, 17.51% had summer break lengths 85-89 days, and 12.22% had summer break lengths 90 days or more. This distribution differed significantly from excluded children ($p < 0.0001$).

Of children included in the study, 37.07% participated in no activities during the summer, 33.56% participated in PA only, 3.09% participated in NPA only, and 26.28% participated in both PA and NPA. This distribution differed significantly from excluded children ($p < 0.0001$).

Variable	Category	Percent		Chi-Square p-value
		Included n=3078	Excluded n=14323	
Kindergarten Overweight Status	Not Overweight	92.85	92.39	
	Overweight	7.15	7.61	0.5864
Summer Length	0-74 days	10.46	13.38	
	75-79 days	35.87	27.86	
	80-84 days	23.94	15.87	
	85-89 days	17.51	30.07	
	>90 days	12.22	12.83	<0.0001
Participation in Activities	No Participation	37.07	47.11	
	PA Only	33.56	27.02	
	NPA Only	3.09	3.36	
	Both PA and NPA	26.28	22.5	<0.0001
Number of Physical Activities	None	40.16	50.53	
	1	32.78	29.62	
	2	19.01	13.76	
	3 or more	8.06	6.09	<0.0001
Number of Non-Physical Activities	None	70.63	74.13	
	At Least 1	29.37	25.87	0.0212
Number of Total Activities	None	11.79	47.11	
	1	37.07	28.81	
	2	32.16	15.04	
	3 or more	18.97	9.04	<0.0001

Table 2b: Descriptive Statistics (cont.)

Of children included in the study, 40.16% participated in no PA, 32.78% participated in one PA, 19.01% participated in two PA's, and 8.06% participated in three or more PA's. This distribution differed significantly from excluded children ($p < 0.0001$).

NPA distribution differed among included and excluded children ($p = 0.0212$). Of children included in the study, 70.63% participated in no NPA's, while 29.37% participated in at least one NPA.

Finally, number of total activities distribution differed among included and excluded children ($p < 0.0001$). Of children included in the study, 11.79% participated in no activities, 37.07% participated in one activity, 32.16% participated in two activities, and 18.97% participated in three or more activities.

Overweight Status Distribution

The distribution of children who were overweight in third grade among predictor variables is presented in Table 3. Distributions for children included in this study are as follows:

- Race: 9.36% of white children were overweight in third grade, compared to 16.18% of African Americans, 15.33% of Hispanics of any race, and 10.16% of other racial descent.
- Gender: Males were more overweight in third grade, at 12.59%, than their female counterparts, at 9.6%.
- Socio-economic status: 14.25% of children in the lowest quintile were overweight, compared to 17.36% in the next highest quintile, 10.82% in the

middle quintile, and 10.19% in the fourth highest, and 6.08% in the highest quintile.

- Town size: 10.17% of children living in large and mid-size cities, 11.88% of children living in mid-size suburbs and large towns, and 11.33% of children living in small towns and rural areas are overweight.

Variable	Category	% Overweight
Spring 3rd Grade Overweight Status	Not Overweight	N/A
	Overweight	
Race	White	9.36
	Black/African-American	16.18
	Hispanic	15.33
	Other	10.16
Gender	Female	9.6
	Male	12.59
SES	1st (Lowest) Group	14.25
	2nd Group	17.36
	3rd (Middle) Group	10.82
	4th Group	10.19
	5th (Highest) Group	6.08
Town Size	Large and Mid Size City	10.17
	Large and Mid Size Suburb and Large Town	11.88
	Small Town and Rural	11.33
Family Construction	Lives with Both parents	10.55
	Lives with One parent	13.37
	Other living arrangement	11.48

Table 3a: Overweight Distribution

Variable	Category	% Overweight
Kindergarten Overweight Status	Not Overweight	5.77
	Overweight	80.45
Summer Length	0-74 days	13.98
	75-79 days	11.5
	80-84 days	11.8
	85-89 days	7.61
	>90 days	11.17
Participation in Activities	No Participation	13.23
	PA Only	10.75
	NPA Only	13.68
	Both PA and NPA	8.28
Number of Physical Activities	None	13.27
	1	10.8
	2	8.55
	3 or more	7.66
Number of Non-Physical Activities	None	12.05
	At Least 1	8.85
Number of Total Activities	None	8.54
	1	13.23
	2	10.91
	3 or more	8.90

Table 3b: Overweight Distribution (cont.)

- Family construction: Those children living in a household that contained neither parent ('other living arrangement') were the least likely to be overweight, with a prevalence of 10.55%. 11.48% of children living with both parents and 13.37% of children living with one parent were overweight.
- Overweight status during kindergarten: 5.77% of those children who were not overweight in kindergarten were overweight by the third grade. By contrast,

80.45% of those who were overweight as kindergartners were overweight as third graders.

- Summer break length: 13.98% of the children in the shortest length of summer break category (74 days or fewer) were overweight. For summer break length of 75-79 days, 11.5% of the children were overweight; a length of 80-84 days, 11.8% of children were overweight; a length of 85-89 days, 7.61% of children were overweight; and a length of 90 or more days, 11.17% of children were overweight.
- Participation in structured summertime activities: 13.23% of children who participated in no structured summertime activities, 10.75% of children who participated in PA only, 13.68% of children who participated in NPA only, and 8.28% of those who participated in both PA and NPA were overweight in third grade.
- Number of PA's: Of children involved in physical activities, 13.27% were overweight if they participated in no physical activities, 10.80% were overweight if they participated in one physical activity, 8.55% were overweight if they participated in two physical activities, and 7.66% were overweight if they participated in three physical activities.
- Number of NPA's: 8.85% of children who were involved in non-physical activities were overweight in third grade. 12.05% of children not involved in non-physical activities were overweight in third grade.
- Total number of activities: 8.54% of children who did not participate in any structured summertime activities, 13.23% of children who participated in one structured summertime activity, 10.91% of children who participated in two

structured summertime activities, and 8.90% of children who participated in three or more structured summertime activities were overweight.

Univariate Results

Univariate results are shown in Table 4. Overweight status among third graders in this study showed statistically significant variation at the $\alpha = 0.05$ level among racial groups, gender, SES, kindergarten overweight status, summer break length, activity participation, number of PA's, number of NPA's, and total number of activities.

Model Selection

To answer Study Objective #2, that participation in structured summertime activities is predictive of overweight status, I evaluated whether or not children participated, the amount of hours they spent participating, and the number of activities in which they participated. The multi-level variable that was created to reflect participation and answer Study Objective #2a (0=no participation in any activities, 1=participation in PA only, 2=participation in NPA only, and 3=participation in both) provided the most information to answer the question of interest. It therefore remained in the model.

I removed the variable assessing time participating in activities from further analysis due to its low cell sizes and subsequent lack of reliability. Of the children that participated in PA, 98% had no data on the amount of time spent participating in these activities. Similarly, of children that participated in NPA, 97% had no recorded hours, and of those that participated in both PA and NPA 74% had no data on hours spent participating in these activities. When combined into a single variable representing total number of hours spent participating in structured summertime activities, 79% had no data.

After reviewing the results from the univariate models (Table 4), I removed variables that did not meet the predetermined requirements for inclusion into the final regression model. The town size variable (p=0.411) was therefore removed.

After removing these variables, multivariate regression models were analyzed. From these analyses, more variables were removed from the model. In all multivariate models, the family construction variable generated p-values > 0.10, and was subsequently removed from the model.

Variables describing the number of PA and NPA in which children participate overlapped considerably with the variable assessing participation. Inadequate cell size resulted in condensing categories in both PA and NPA: NPA was forced to become a yes/no variable, which added little explanatory value beyond the first variable. Because PA still contained a range of 0 to 3 activities, I evaluated it in the multivariate models.

However, when inserted into models with activity participation, it offered little increase in explanatory value to the model. I also evaluated the total number of activities in which a child participated in multivariate models. It also offered little explanatory value to the models. Therefore, due to low cell sizes and their inability to provide reliable estimates of their relationships with the outcome variable, I removed these variables from the analysis.

Variable	Overall p-value	Category	OR	95% CI Lower	95% CI Upper	P-value
Race	<.0001	Black/African-American	1.87	1.366	2.561	<.0001
		Hispanic	1.754	1.292	2.381	0.0003
		Other	1.096	0.755	1.592	0.6298
		White	(Referent)			
Gender	0.0085	Female	0.737	0.588	0.925	0.0085
		Male	(Referent)			
SES	<.0001	2nd Group	1.264	0.89	1.795	0.1907
		3rd (Middle) Group	0.73	0.505	1.056	0.0945
		4th Group	0.683	0.471	0.99	0.044
		5th (Highest) Group	0.389	0.261	0.581	<.0001
		1st (Lowest) Group	(Referent)			
Town Size	0.411	Large and Mid Size Suburb and Large Town	1.192	0.918	1.547	0.1873
		Small Town and Rural	1.129	0.84	1.517	0.4203
		Large and Mid Size City	(Referent)			
Family	0.1491	Lives with One parent	1.308	0.999	1.714	0.0512
		Other living arrangement	1.099	0.495	2.44	0.817
		Lives with Both parents	(Referent)			
Kindergarten Overweight Status	<.0001	Overweight	67.181	46.477	97.109	<.0001
		Not Overweight	(Referent)			
Summer Length	0.0451	75-79 days	0.8	0.555	1.153	0.2316
		80-84 days	0.824	0.56	1.212	0.3258
		85-89 days	0.507	0.324	0.793	0.0029
		>90 days	0.774	0.494	1.214	0.2643
		0-74 days	(Referent)			
Participation in Activities	0.0062	PA Only	0.789	0.608	1.025	0.0756
		NPA Only	1.039	0.565	1.912	0.9011
		Both PA and NPA	0.592	0.437	0.802	0.0007
		No Participation	(Referent)			
Number of Physical Activities	0.0055	1	0.792	0.612	1.025	0.0758
		2	0.611	0.438	0.852	0.0037
		3	0.542	0.33	0.891	0.0156
		None	(Referent)			
Number of Non-Physical Activities	0.0104	At Least 1	0.709	0.545	0.922	0.0104
		None	(Referent)			
Number of Total Activities	0.0151	1	0.803	0.617	1.044	0.1017
		2	0.641	0.46	0.894	0.0087
		3	0.612	0.408	0.919	0.0179
		None	(Referent)			

Table 4: Results from Univariate Analysis

Kindergarten overweight status was evaluated for its interacting properties with the other covariates due to the effects that previous weight status has on future weight status (Freedman et al, 2005). Other possible interactions were not evaluated to abstain from generating results that had little interpretative meaning. Using a backwards elimination technique in the multivariate model, interactions between kindergarten overweight status and each of the variables SES, summer length, race, and activity participation were removed. The interaction between gender and kindergarten overweight status retained statistical significance, generating a p-value in the final model of 0.0469.

The final model chosen for analysis included the predictor variables describing race, gender, socio-economic status (SES), kindergarten (baseline) overweight status, summer length, type of summertime activity (PA, NPA, both, or none), and interaction terms describing interactions of kindergarten overweight status with gender.

Multivariate Regression Model Results

Table 5 displays results from the multivariate regression model.

Summer Break Length and Overweight Status

Summer break length, when entered into the multivariate model, generated an overall p-value of 0.0183. The category with the lowest number of days, 0-74 days, was used as the referent category in the model. The only category within the summer break length variable to show statistical significance was 85-89 days: the odds of being overweight in third grade among those whose summer break was 85-89 days were about half the odds of being overweight in third grade among those whose summer break was less than 74 days (p= 0.0376).

Although not all statistically significant, the odds ratios generated by the model displayed an interesting pattern. As summer break length increased, the odds of being overweight in third grade changed. There were increased odds of being overweight for those with summer breaks of 75-79 days and 90+: 1.20 (95% CI=0.74-1.95) for 75-79 days and 1.16 (95% CI=0.64-2.08) for 90+ days.

Variable	Overall p-value	Category	β	± se	OR	95% CI	
Race	0.0049	White	Referent				
		Black	0.68	0.20	1.97**	1.32	2.94
		Hispanic	0.20	0.22	1.22	0.80	1.86
		Other	-0.15	0.25	0.87	0.53	1.42
SES	0.0017	1st (Lowest) Group	Referent				
		2nd Group	0.32	0.24	1.38	0.87	2.19
		3rd (Middle) Group	-0.16	0.25	0.85	0.52	1.38
		4th Group	-0.32	0.26	0.73	0.43	1.22
		5th (Highest) Group	-0.67	0.28	0.514*	0.30	0.89
Summer Length	0.0183	0-74 days	Referent				
		75-79 days	0.18	0.25	1.20	0.74	1.95
		80-84 days	-0.12	0.26	0.88	0.53	1.48
		85-89 days	-0.63	0.30	0.534*	0.30	0.97
		90 or more days	0.15	0.30	1.16	0.64	2.08
Activity	0.5734	No Activity	Referent				
		PA only	0.09	0.18	1.09	0.77	1.55
		NPA only	0.14	0.39	1.14	0.53	2.48
		Both PA and NPA	-0.20	0.21	0.82	0.54	1.24
Interaction Gender * Kindergarten Overweight Status	0.0469	OWK (Sex=Male)	No estimate		51.6117	31.657	84.1448
		OWK (Sex=Female)			113.7	61.3451	210.9
		Sex (Not OW)			0.649	0.4691	0.898
		Sex (Overweight)			1.4303	0.7038	2.9065

Table 5: Results of Multivariate Analysis

There were decreased odds of being overweight for the other summer break length categories: 0.88 (95% CI=0.53-1.48) for 80-84 days and 0.53 (95% CI=0.30-0.97) for 85-89 days.

Structured Activity during Summer and Overweight Status

The relationship between structured activities and overweight status during third grade was not statistically significant at the α=0.05 level in the multivariate model (p= 0.5734). There were no significant differences between children who engaged in no activities, those who engaged in PA, those who engaged in NPA, and those who engaged in both PA and NPA.

Although not statistically significant, the results show that the odds of being overweight in third grade for those who participate in PA only are 1.09 (95% CI=0.77-1.55) times the odds of being overweight in third grade for those who participate in no activities. The odds of being overweight in third grade for those who participate in NPA only are 1.14 (95% CI=0.53-2.48) times the odds of being overweight in third grade for those who participate in no activities. The odds of being overweight in third grade for those who participate in both types of activities is 0.82 (95% CI=0.54-1.24) the odds of being overweight in third grade for those who participate in no activities.

Covariate Significance

Several covariates in the multivariate logistic regression model showed statistical significance at the α=0.05 level. First, the odds of overweight status of third grade African-American children are 1.97 (95% CI=1.32-2.94) times those of White, non-Hispanic children. Higher SES shows less chance of overweight status in third grade. The odds of being overweight in third grade for those children in the 5th (highest) group of SES were 0.51 (95% CI=0.30-0.89) times those in the 1st (lowest) group. Because the interaction term between kindergarten overweight status and gender was statistically significant in the model, interpretation of the results regarding gender and kindergarten overweight status is more complicated than those for race and SES (see the interaction section below for details).

Confounding

Several variables were assessed for their roles as confounders of the effects between the type of activity and overweight status of children in third grade. First, a univariate logistic regression model compared overweight status and activity type. Then, each individual predictor variable was added to this model, yielding bivariate models. Changes in significance levels (p-values) and odds ratios between the univariate and bivariate models were assessed. The biggest change in p-values between univariate and bivariate models was displayed when SES and activity type were entered together into the bivariate model. The p-value generated by the activity type variable increased from 0.0062 to 0.5429 – from significant to highly not significant at the alpha=0.05 level – when SES is added. The odds ratios for each level of activity also increased: for PA, the odds ratio increased from 0.789 to 0.969; for NPA, the odds ratios increased from 1.039 to 1.155; and for both PA and NPA, the odds ratio increased from 0.592 to 0.81.

The increase in odds ratios for PA and Both PA and NPA were both toward the null, signifying that SES dilutes the effects of PA and Both PA and NPA. On the other hand, the odds ratio for NPA increased away from the null. It was the smallest change in odds ratios of the three categories (0.116, 11.2%).

Further exploration of this relationship shows how SES acts as a confounder between the type of activity in which a child participated and the outcome variable, third grade overweight status. Dividing the children by SES category showed that most fall in the highest SES category (n=790). Within this category, almost 46% participated in both PA and NPA, while about 14% participated in no activities. The lowest SES group (the reference group) contained the fewest children (n=421), and only 9% participated in both PA and NPA, while 70% participated in no activities. Across all SES categories, the number of children who participated in both activities increased with increasing SES status while the number of children who participated no activities decreased with increasing SES. Therefore, those children of higher SES were both more likely to participate in activities and less likely to be overweight (Tables 5 and 6). These differences show that SES confounds the relationship between activity participation and third grade overweight status.

% of SES category		**Activity**			
		None	**PA**	**NPA**	**Both**
SES	1	70.1	17.3	3.6	9.0
	2	52.1	28.0	3.3	16.6
	3	41.1	36.8	3.3	18.9
	4	26.7	40.6	3.6	29.1
	5	14.4	37.5	2.2	46.0

Table 6: Activity Participation by SES Group.

The same procedure was employed for kindergarten overweight status. The p-value of the activity type variable increased from 0.0062 to 0.1354 – from significant to highly not significant at the α=0.05 level – when kindergarten overweight status was added to the univariate model that compared activity level and third grade overweight status. The odds ratios for each level of activity also increased: for PA, the odds ratio increased from 0.789 to 0.889; for NPA, the odds ratios increased from 1.039 to 1.106; and both PA and NPA the odds ratio increased from 0.592 to 0.644.

The increase in odds ratios for PA and Both PA and NPA were both toward the null, signifying that kindergarten overweight status dilutes the effects of PA and Both PA and NPA. On the other hand, though it was a small change (0.067, 6.4%), the odds ratio for NPA increased away from the null.

The relationship was explored by evaluating third grade overweight status and activity participation, stratifying by kindergarten overweight status. Children who participated in both PA and NPA represented 20.4% of children who were overweight in kindergarten, while they represented 26.7% of children who were not overweight in kindergarten. Also, children who participated in no activities represented 45.5% of children who were overweight in kindergarten, while they represent 36.4% of children who were not overweight in kindergarten. Therefore, children who were overweight in kindergarten were more likely to be overweight in third grade and less likely to have participated in structured summertime activities (Tables 5 and 7). These differences show that kindergarten overweight status confounds the relationship between activity participation and third grade overweight status.

% of Kindergarten Over-weight Status category		Activity			
		None	**PA**	**NPA**	**Both**
Kindergarten Overweight Status	Not OW	36.4	33.8	3.0	26.7
	OW	45.5	30.5	3.6	20.5

Table 7: Activity Participation by Kindergarten Overweight Status.

Interactions

The interaction term between kindergarten overweight status and gender was statistically significant at the α=0.05 level, and generates results worth noting. First, the odds ratios that compare overweight status in third grade by kindergarten overweight status differ depending on gender. The odds of being overweight in third grade for females who are overweight in kindergarten are 113.7 times the odds of being overweight in third grade for females who are not overweight in kindergarten ($p < 0.0001$). However, the odds of being overweight in third grade for males who are overweight in kindergarten are 51.6 times the odds of being overweight in third grade for males who are not overweight in kindergarten ($p < 0.0001$). The odds ratio for females is over twice the odds ratio for males.

Likewise, the odds ratios that compare overweight status in third grade by gender differ depending on kindergarten overweight status. The odds of being overweight in third grade for females who were overweight in kindergarten are 1.43 times the odds of being overweight in third grade for males who were overweight in kindergarten ($p=0.3226$). However, the odds of being overweight in third grade for females who were not overweight in kindergarten were 0.65 times the odds of being overweight in third grade for males who were not overweight in kindergarten ($p=0.0091$).

Discussion

The goal of this study was to evaluate the effects that the length of summer break from school and participation in structured summertime activities have on overweight status of elementary-age school children.

In general, activity level was not predictive of third grade overweight status in the multivariate model; it did not generate statistically significant results. However, children with a summer break length of 85-89 days showed statistically significant decreased odds of being overweight in third grade than children with the shortest summer breaks. Further, other variables – race, SES, gender, and kindergarten overweight status – were predictive of overweight status in third grade.

Interpretations

Summer Break Length

Although limited by the restrictions of the data, the results suggest that the amount of time away from school may be important in helping children prevent becoming overweight at an early age. However, this interpretation requires further evaluation. As previously mentioned, the study by von Hippel et al (2007) showed children gain weight more quickly during summer break than during school, while the study by Haines et al (2003) showed increased caloric intake during weekends and holidays – time away from the structured environment of work or school. On the other hand, conventional wisdom associates the school environment with less physical activity and summer break with increased physical activity, as children have more free time to go outside and play. These two opposing viewpoints may be explanatory of the mixed results of this study, and can be used to drive new studies to explore these hypotheses. This issue warrants further investigation with more reliable data.

Structured Summertime Activity Participation

Although there was not a statistically significant relationship between participation in summertime activity and third grade overweight status, univariate results show that physical activity is protective against overweight status. Decreasing statistical significance accompanying insertion of covariates demonstrates the complex nature of the pathways to becoming overweight. Because of the intertwining pathways that lead to obesity in childhood and adolescence (Reilly et al, 2007), multiple studies examining these complex relationships are needed to better inform public health recommendations.

Confounding

Further explanation relies on investigating confounding factors. Statistically significant confounding of summer break length by SES and kindergarten overweight status demonstrates some of the complexities of the pathways to overweight status in children. Those of higher SES groups are more likely to have resources to prevent overweight status, such as safer neighborhoods with access to parks and other recreational areas that increase physical activities (Gordon-Larsen et al, 2006), greater consumption of healthy foods (De Irala-Estevez et al, 2000), and peer influences that promote activity (Sweeting, 2008). Under the same logic, children of higher SES would be more likely to attend a summer camp, be tutored, and participate in other structured activities. In this study, therefore, structured summertime activities act as a proxy for SES.

Kindergarten overweight status also confounds the relationship between activity participation and third grade overweight status. Children overweight in kindergarten are much more likely to be overweight in third grade than children not overweight in kindergarten. These children may be limited by their overweight status in the amount of activities in which they participate.

The effects of these confounding factors are consistent with literature on obesity and overweight etiology. Further research is needed to untangle these relationships. For example, an analysis that is stratified by levels of SES could be used to analyze the relationships that other predictors have with third grade overweight status, and offer a clearer understanding of the confounding effects of SES.

Interactions

I investigated interactions between kindergarten overweight status and other predictor variables due to presumed effects that previous overweight status may have on physical development (Freedman et al, 2005). The interaction between kindergarten overweight status and gender offers a look into how male and female children gain weight differently.

Females who are overweight in kindergarten are more likely than males to stay overweight. Also, females who start not overweight are less likely than males who start not overweight to become overweight. Overall, females are less susceptible to changes in body composition between kindergarten and third grade.

Whereas drawing conclusions about this relationship would require a more detailed look into social and developmental differences between males and females, some explanations to these findings can be offered. First, males and females experience different peer influences regarding exercise and food intake: males may be more inclined to susceptibility from these peer influences than females, and therefore more able to change their body composition (Kohl et al, 1998). Also, differences in energy intake and expenditure patterns between males and females have been observed, and these may be rooted in social constructs (Sweeting, 2008).

Understanding differences in physical development patterns among males and females is important to public health policy. If females gain weight differently than males, intervention strategies tailored to the needs of each gender could be more effective in overweight prevention. Timing of interventions also could be important in prevention of overweight status. It is beyond the scope of this study to assess effects of timing as more changes in weight status most likely occur beyond the age at which a child is in third grade.

Limitations

The ECLS-K was a sub-sample of American children, and this study used a limited number of those children to make its assessments. Further, because the sub-sample I used for the assessments was small, I decided not to employ a weighting strategy. The results from this study therefore cannot be generalized to the general population.

The calculation of summer break length relied on assumptions about the child's enrollment in school. Because the ECLS-K question asked about the beginning and ending dates of the school year, I calculated the summer break length as 365 days minus this period of time. This assumes that the first grade and kindergarten school years were the same, and that children did not switch schools between kindergarten and first grade. It also assumes that the summer break length measured by ECLS-K (the summer between kindergarten and first grade) was consistent throughout the analysis period, i.e. was the same between first and second, and second and third grades. The need for these assumptions was due to limitations in the dataset.

Because one of this study's objectives looks to compare overweight status of children by summer break lengths, the study must assume a consistent summer break length between kindergarten and third grade based on the summer between kindergarten and first grade. This is necessary for summer break length to represent a reprieve from structured activity. However, unless there were reasons to assume that changing schools between kindergarten and third grade would cause differences among overweight and not overweight children, these assumptions should not challenge the results.

I classified summertime activities in which children participate into physical, non-physical, or both. These activities may reflect what a child did during the summer. However, the camp participation questions in the ECLS-K survey asked what activities the child's camp offered. From this I assumed that the child participated in this activity only, and not in other activities. Just because a child indicated that s/he attended a camp that offered arts and crafts, which I categorized as NPA, does not exclude the child from having participated in another form of PA, which I would not have counted.

The assigned categories fail to quantify the amounts of activity. Time was measured by ECLS-K by self-report, which is not a recommended measurement for children less than 10 years of age (Kohl et al, 1998). And, it was measured only for camp and tutor participation (not other PA and NPA). My efforts to quantify activity quantity led to small cell sizes and an inability to draw conclusions with statistical certainty. Whereas the ECLS-K offers insight into many aspects of child development, it is ill-equipped to answer questions about time spent in summertime activities.

The limitations of the dataset warrant further investigation using more accurate and precise measurement techniques. Studies that provide better measurements of the predictor variables, including length of summer break and activity participation as well as a more complete assessment of confounding variables, would allow further insight into the possible relationships these have with overweight status. By collecting data in more frequent intervals, precision could be increased to provide more reliable results.

Conclusions

The results of this study could be used to help shape public health policy. For example, summer break length could be chosen to optimize the protective benefits it may have against overweight status. Schools could also offer activities that provide a structured environment during the summer. As the interactions showed differences in weight gain between males and females, weight control interventions that differ by gender could be used to prevent overweight status. And, as weight gain continues with growth, timing intervention programs to target the highest risk time periods could be beneficial.

To further increase the knowledge gained from this study, other analyses could be conducted. As previously mentioned, stratification by SES category could increase understanding of its role in activity participation. The outcome group, overweight children, represented only 11% of the children in our study. A comparison between this 11% and a smaller segment of lower BMI z-scores (e.g. the lowest quartile), could offer better insight into the differences seen in the overweight group. Also, stratifying by gender the relationships that PA and NPA have with overweight status could offer further explanation to the interaction between gender and kindergarten overweight status. Finally, comparing children with the traditional summer break length to children who attend year-round schools also may help uncover a relationship between overweight status and structured activity.

References

Allison, D. B., Fontaine, K. R., Manson, J. E., Stevens, J., VanItallie T. B. Annual Deaths Attributable to Obesity in the United States. *Journal of the American Medical Association*, 1999; 282 (16): 1530-1538.

Andreyeva, T., Sturm, R., Ringel, J. S. Moderate and Severe Obesity have Large Differences in Health Care Costs. *Obesity Research,* 2004; 12 (12): 1936-1943.

De Irala-Estevez, J., Groth, M., Johansson, L., Oltersdorf, U., Prattala, R., et al. A Systematic Review of Socio-economic Differences in Food Habits in Europe: Consumption of Fruit and Vegetables. *European Journal of Clinical Nutrition*, 2000; 54: 706-714.

Ferraro, K. F., Thorpe, R. J., Wilkinson, J. A. The Life Course of Sever Obesity: Does Childhood Overweight Matter? *Journal of Gerontology,* 2003; 58B (2): S110-S119.

Flegal, K. M., Carroll, M. D., Ogden, C. L., Johnson, C. L. Prevalence and Trends in Obesity among US Adults, 1999-2000. *Journal of the American Medical Association,* 2002; 288 (14): 1723-1727.

Freedman, D. S., Khan, L. K., Serdula, M. K., Dietz, W. H., Srinizasan, S. R., et al. The Relation of Childhood BMI to Adult Adiposity: The Bogalusa Heart Study. *Pediatrics,* 2005; 115; (1): 22-27.

Gordon-Larsen, P., Nelson, M. C., Page, P., Popkin, B. M. Inequality in the Built Environment Underlies Key Health Disparities in Physical Activity and Obesity. *Pediatrics*, 2006; 117 (2): 417-424.

Giovannucci, E., Ascherio, A., Rimm, E.B., Colditz, G. A., Stampfer, M. J., et al. Physical Activity, Obesity, and Risk for Colon Cancer and Adenoma in Men. *Annals of Internal Medicine*, 1995; 122 (5): 327-334.

Haines, P. S., Hama, M. Y., Guilkey, D. K., Popkin, B. M. Weekend Eating in the United States is Linked with Greater Energy, Fat, and Alcohol Intake. *Obesity research,* 2003; 11 (8): 945-949.

Hill, J. O. Understanding and Addressing the Epidemic of Obesity: An Energy Balance Perspective. *Endocrine Reviews,* 2002; 27 (7): 750-761.

Himes, J. H., Dietz, W. H. Guidelines for Overweight in Adolescent Preventive Services: Recommendations from an Expert Committee. *American Journal of Clinical Nutrition*, 1994; 59 (2): 307-316.

Jeffery, R. W., Utter, J. The Changing Environment and Population Obesity in the United States. *Obesity Research*, 2003; 11 (10S): 12S-22S.

Kannel, W. B., Cupples, L. A., Ramaswami, R., Stokes III, J., Kreger, B. E., et al. Regional Obesity and Risk of Cardiovascular Disease; the Framingham Study. *Journal of Clinical Epidemiology*, 1991; 44 (2): 183-190.

Kohl III, H. W., Hobbs, K. E. Development of Physical Activity Behaviors among Children and Adolescents. *Pediatrics*, 1998; 101 (3 Pt 2): 549-54.

Kuczmarski R. J., Ogden, C. L., Brummer-Strawn, L. M., Flegal, K. M., Guo, S. S., et al. *CDC Growth Charts: United States*. Atlanta, GA: Centers for Disease Control and Prevention; 2000.

Mokdad, A. H., Ford, E. S., Bowman, B. A., Dietz, W. H., Vinicor, F., et al. Prevalence of Obesity, Diabetes, and Obesity-Related Health Risk Factors, 2001. *Journal of the American Medical Association,* 2003; 289 (1): 76-79.

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

Ogden, C. L., Carroll, M. D., Flegal, K. M. High Body Mass Index for Age among US Children and Adolescents, 2003-2006. *Journal of the American Medical Association*, 2008; 299 (20): 2401-2405.

Reilly, J. J., Ness, A. R., Sherriff, A. Epidemiological and Physiological Approaches to Understanding the Etiology of Pediatric Obesity: Finding the Needle in the Haystack. *Pediatric Research*, 2007; 61 (6): 646-652.

Sweeting, H. N. Gendered Dimensions of Obesity in Childhood and Adolescence. *Nutritional Journal*, 2008; 7:1.

Toschke, A. M., Ruckinger, S., Bohler, E., Von Kries, R. Adjusted Population Attributable Fractions and Preventable Potential of Risk Factors for Childhood Obesity. *Public Health Nutrition,* 2007; 10 (9): 902-906.

Troiano, R. P., Flegal, K. M. Overweight Children and Adolescents: Description, Epidemiology, and Demographics. *Pediatrics,* 1998; 101 (3): 497-504.

U.S. Department of Education, National Center for Education Statistics. (2001). *ECLS-K Base Year Public-Use Child File* (CD-ROM and user's manual). (NCES 2001-029). Washington, DC: Author.

U.S. Department of Education, National Center for Education Statistics. (2004). *ECLS-K Third Grade Public-Use Data File* (CD-ROM). (NCES 2004-002). Washington, DC: Author.

U.S. Department of Education, National Center for Education Statistics. (2004). *User's Manual for ECLS-K Third Grade Public Use Data Files and Electronic Codebook*. (NCES 2004-001).

von Hippel, P. T., Powell, B., Downey, D. B., Rowland, N. J. The Effect of School on Overweight in Childhood: Gain in Body Mass Index during the School Year and During Summer Vacation. *American Journal of Public Health,* 2007; 97 (4): 696-702.

Wolf, A. M. Economic Outcomes of the Obese Patient. *Obesity Research,* 2002; 10 (1): 58S-62S.