Psychosocial, Socioeconomic, Behavioral, and Environmental Risk Factors for BMI and Overweight Among 9- to 11-Year-Old Children

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Abstract

This study explored the risk factors for higher BMI and overweight in 9- to 11-year-old children using the 2007 *California Children's Healthy Eating and Exercise Practices Survey*. A total of 741 children completed a two-day food and activity diary. Of these, 299 children participated in the follow-up telephone interview, reporting attitudes and beliefs. Linear regressions identified risk factors related to BMI *z*-scores; logistic regressions were used for binomial overweight status. Independent variables included children's diet, activity, screen time, food modeling, family norms/rules, home environment, poverty, and parent education, adjusting for race/ethnicity. Parent education was the strongest risk factor with a clear gradient towards reduced risk as parent education improved. Children were .3 BMI *z* points lower and one-third less likely to be overweight as education level rose. Each serving of fried vegetables consumed was related to .3 point increase in BMI *z*. Children were 1.2-1.3 times more likely to be overweight with each increase in school lunch participation. Low-cost overweight prevention efforts targeting children with less parent education, school lunches, and consumption of fried vegetables may reduce BMI and help prevent childhood overweight. Additional investigation should determine the underlying factors contributing to the relationship between eating school lunch and overweight.

Keywords: BMI and overweight, child, regression, parent education, diet, school lunch

Introduction

Overweight is an increasingly serious health concern for children. Nationally, one-third of children ages 6 to 11 are overweight (Ogden, Carroll, & Flegal, 2008). Overweight children experience medical and psychosocial consequences such as hypertension, sleep apnea, bullying, poor self-image, low self-esteem, and glucose intolerance (Koplan, Liverman, & Kraak, 2005; Lee, 2009). In addition, they are more likely to become overweight adults (Dietz, 1998; Guo, Wu, Chumlea, & Roche, 2002). Adults who were once overweight children, regardless of adult weight, also experience higher risk of obesity-related health problems (Field, Cook, & Gillman, 2005). Thus, preventing and reducing the prevalence of childhood overweight is essential to improve the current health status of children and to promote optimal health as they grow up.

Numerous factors have demonstrated associations with childhood overweight and obesity. Commonly studied predictors of childhood overweight include, but are not limited to, demographic characteristics, such as gender, age, and race/ethnicity (Martin & Ferris, 2007; Singh, Kogan, Van Dyck, & Siahpush, 2008); socioeconomic factors, such as parent education, poverty, and food insecurity (Bhargava, Jolliffe, & Howard, 2008; Martin & Ferris, 2007; Singh et al., 2008); psychosocial factors, such as family support and peer influence (Davison & Birch, 2002; Drewnowski, Rehm, Kao, & Goldstein, 2009; Robinson, Kiernan, Matheson, & Haydel, 2001; Romero, Epstein, & Salvy, 2009); behaviors, such as dietary practices, physical activity, and sedentary practices (Johnson, Mander, Jones, Emmett, & Jebb, 2008; K. R. Laurson et al., 2008; Singh et al., 2008); and environmental factors, such as school foods, family meals, and neighborhood assets (Fox, Dodd, Wilson, & Gleason, 2009; Franzini et al., 2009; Gable, Chang, & Krull, 2007). An essential issue for public health practitioners is identifying what overarching factors that contribute to childhood overweight can be modified through interventions and policy. The purpose of this study is to examine data available in a cross-sectional, statewide children's survey to identify risk factors for childhood overweight that may be addressed by parents, schools, and through other public health approaches.

Socioeconomic Factors and Childhood Overweight

The relationship between obesity and economics, specifically poverty, presents something of a paradox. Although one might expect the low-income population to be thin because they are undernourished, in the United States (U.S.) the poor tend to be disproportionately overweight (Center on Hunger and Poverty and Food Research and Action Center, 2009). Many studies have examined the association between food insecurity and overweight among children, however, the findings have been inconclusive (Dinour, Bergen, & Yeh, 2007; Drewnowski et al., 2009). According to a recent, comprehensive review, patterns of association between food insecurity and BMI in children often conflict, and the patterns appear to vary based on age, gender, race/ethnicity, and household income (Dinour et al., 2007). However, a recent California study demonstrated consistent statewide associations between household poverty and childhood overweight. Drewnowski and colleagues (2009) examined the California Fitnessgram data and found that when rates of poverty and prevalence of childhood overweight were aggregated to California assembly districts, the districts with higher poverty also had higher mean prevalence of child BMI. Poverty level predicted overweight across gender and race/ethnic groups (Drewnowski et al., 2009).

Parent education has also been related to childhood overweight; however, limited studies have examined this risk factor. One study specifically examined the relationship between family circumstances and weight status, showing that children with less educated parents tended to have a higher BMI and were more likely to be overweight (Hesketh, Crawford, Salmon, Jackson, & Campbell, 2007). A few studies conducted more comprehensive analyses of socioeconomic, behavioral, and environmental risk factors and found children's body weights and likelihood of obesity were significantly lower in households with higher parent education (Bhargava et al., 2008; Rose & Bodor, 2006; Singh et al., 2008). Current research suggests that household poverty and parent education influence child BMI and overweight.

Family and Peer Influences on Childhood Overweight

Both parental behaviors and peer influence are associated with children's weight. Davison and Birch (2002) identified an obesigenic family as one in which parents have high energy intake relative to body weight, high percentage of calories as fat, and high dietary disinhibition accompanied by low physical activity; non-obesigenic families exhibit an opposite pattern. This obesigenic pattern was associated with higher BMI and skinfold thickness among young girls (five years old) and with increases in these measures over time. At ages 9 and 11, the same girls continued to have significantly higher BMI and body fat measurements than those from non-obesigenic homes; girls from obesigenic families also had significantly higher percentage fat intake and television viewing (Krahnstoever-Davison, Francis, & Birch, 2005). Parent modeling and support, family norms, and the home environment appear to contribute to child BMI.

Parental influence over children's eating has been associated with child BMI in more than one study, but results conflict. For example, Fisher and Birch (1999) found that as parental control over food increased, so did children's weight. In contrast, other studies have found no relationship or an inverse association between parental food restriction and weight (Brown, Ogden, Vogele, & Gibson, 2008; Larios, Ayala, Arredondo, Baquero, & Elder, 2009; Robinson et al., 2001). No clear pattern has emerged regarding how parental control over eating impacts children's weight, but it would be valuable to explore the impact of family rules related to food on child BMI and overweight.

The influence of peers on the weight status of children is an under-studied area. However, inferences can be drawn from recent research which has suggested that teenagers' BMI is positively associated with their friends' BMI (Renna, Grafova, & Thakur, 2008; Robinson et al., 2001; Trogdon, Nonnemaker, & Pais, 2008). This association appears to be strongest among girls and for same-sex friends (Renna et al., 2008). Among preadolescent children, research has indicated that peers may influence specific behaviors, such as fruit and vegetable consumption (Rasmussen et al., 2006) and snack portions (Romero et al., 2009). Furthermore, a recent study showed that regardless of weight, older children and adolescents ate more when they snacked with a friend rather than with an unfamiliar peer, with the biggest calorie intakes observed when an overweight child snacked with an overweight friend (Salvy, Howard, Read, & Mele, 2009). Peer modeling influences children's diet and may also be associated with childhood overweight.

Diet and Childhood Overweight

Research has shown a number of correlations between general dietary patterns and specific dietary behaviors with children's weight. Correlations with increased body fat were found for consumption of an energy dense, low-fiber, high-fat diet among children (Johnson et al., 2008). Conversely, correlations with lower BMI or obesity rates have been demonstrated with increased milk consumption (Barba, Troiano, Russo, Venezia, & Siani, 2005), higher fruit and vegetable intake (Lin & Morrison, 2002; Rockett, Berkey, Field, & Colditz, 2001), eating school breakfast (P. M. Gleason & Dodd, 2009), and daily consumption of breakfast, especially breakfast cereal (Panagiotakos et al., 2008). Additional investigation of specific foods may help identify which foods, if any, are protective against or contribute to childhood overweight.

As families rely increasingly on food prepared outside of the home (Guthrie, Lin, & Frazao, 2002), there is concern that increased consumption of fast food, take out, and restaurant food may lead to overweight and obesity in children. Hesketh and colleagues (2009) found that one significant risk factor for childhood overweight in their sample was frequency of eating take-out food. In a study comparing children's weight status based on their families' most common restaurant choice, fast food as the primary restaurant choice put children at significantly greater risk of overweight (Duerksen et al., 2007). Eating fast food appears to relate to child overweight.

The Role of Physical Activity and Screen Time on Childhood Overweight

Physical activity (PA) is essential for good health and important regardless of weight status (U.S. Department of Health and Human Services, 1996). Increased PA is associated with lower rates of overweight and obesity in children (K. R. Laurson et al., 2008; Must et al., 2007). This finding emerges in both self- and parent-reports of activity (Franzini et al., 2009) as well as more rigorous studies using objective measures of these variables (Ness et al., 2007; Patrick et al., 2004). Moreover, not only the amount of PA is important, but also the type; children engaging in vigorous PA are less likely to be overweight or obese than children doing moderate PA (Wittmeier, Mollard, & Kriellaars, 2008).

Conversely, sedentary activity is related to childhood obesity. Sedentary activity encompassing "screen time" spent watching television, playing video games, or on a computer has been associated with higher rates of overweight and obesity in children (Laurson, Eisenmann, & Moore, 2008; K. R. Laurson et al., 2008). In a longitudinal study assessing BMI change between kindergarten and fifth grade, children watching four hours of television daily compared to one hour gained an estimated .42 BMI points (Danner, 2008). Greater amounts of television watching have been associated not only with the onset of overweight, but also with increased persistence of overweight over time (Gable et al., 2007). Taken together, this evidence suggests that both PA and sedentary activity play a critical role in childhood overweight.

Health and Nutrition Education and Childhood Overweight

Nutrition education can support efforts to prevent childhood obesity. The Planet Health program targets four behaviors: reducing TV viewing, increasing moderate to vigorous PA, decreasing high-fat food consumption, and increasing fruit and vegetable consumption. A successful program among 6th and 7th graders that reduced school-wide rates of obesity for girls, but not boys; the intervention's effect on girls was mediated by a reduction in TV viewing, with a one hour reduction in daily TV viewing resulting in a significant reduction in obesity (Gortmaker et al., 1999). Other examples of successful school-based obesity prevention among children include the Medical College of Georgia's FitKid Project (Yin et al., 2005), the multi-component School Nutrition Policy Initiative (Foster et al., 2008), CATCH (Edmundson et al., 1996), and Shape Up Somerville (Economos et al., 2007). These successful obesity prevention projects targeted multiple behaviors related to diet and activity among school children. While not tested for impact on obesity, it stands to reason that other successful interventions and school-based nutrition education programs aimed to improve diet, PA, screen time, or overall health would also help prevent childhood obesity (Anderson et al., 2005; Baranowski et al., 2003; Baranowski et al., 2000; Foerster et al., 1998; Huhman et al., 2007; Robinson, 1999).

Environmental Factors and Childhood Overweight

Factors in a child's home, school, and neighborhood environment have been associated with overweight. The presence of a television in a child's bedroom increases risk of overweight and obesity during childhood (Adachi-Mejia et al., 2007) and early adolescence (Delmas et al., 2007). Studies have also demonstrated the relationships between school food environments and practices associated with overweight. Offering fried foods and providing desserts more than once a week were associated with a higher likelihood of being overweight among elementary school children (Fox et al., 2009). Participation in the School Breakfast Program was linked to a lower BMI (P. M. Gleason & Dodd, 2009). The proximity of a park with a playground, but not a park without a playground, substantially decreased risk of overweight (Potwarka, Kaczynski, & Flack, 2008). Investigating the home, school, and neighborhood environments that children live and play in may help identify risk factors for BMI and overweight.

Socioeconomic and psychosocial factors, food intake and dietary practices, PA, screen time, nutrition education, as well as home, school, and neighborhood environment are each associated with overweight among children. Much of the existing literature on child overweight and obesity addresses a limited set of variables at a time, which can make it difficult to determine which ones directly influence children's weight. Logically, it is reasonable that all of these risk factors could act together to impact childhood overweight.

Research Purpose

Measures of these variables are all present in the *California Children's Healthy Eating and Exercise Practices Survey* (*CalCHEEPS*), a statewide biennial survey run by the California Department of Public Health (CDPH), *Network for a Healthy California*. The survey is designed to gain a better understanding of California's 9- to 11-year-old children with specific emphasis on dietary intake and practices, PA and screen time, knowledge and awareness of the *Children's Power Play! Campaign* (Foerster et al., 1998), together with factors that influence these behaviors such as out-of-home eating, social norms, home and school environment, poverty, weight status, and attitudes and beliefs.

This study aims to take advantage of the available *CalCHEEPS* data to identify the primary socioeconomic, psychosocial, behavioral, and environmental risk factors for BMI and overweight in California 9- to 11-year-old children.

Methods

Data Description

This cross-sectional study analyzed data from the 2007 *CalCHEEPS*. *CalCHEEPS* is the most comprehensive survey of dietary intake, PA, and weight status among 9- to 11-year-old children in California. Statewide surveillance is conducted using a market research panel of approximately 3,500 English-speaking households with 9- to 11-year-old children assembled by Synovate Global Opinion Panels. Only one child per household was invited to participate in the study. This method is pragmatic and cost-effective for reaching the target audience, when fewer than 12 percent of California households have a child in this age range. The panel represents 54 of California's 58 counties, produces a panel of households with demographic profiles similar to those found statewide, enables CDPH to oversample low-income households, provides a trusted source of information for panel members, and facilitates the consent process. However, because the panel is limited to English-speaking households, it under represents households in which English is not the primary language.

CalCHEEPS includes a self-administered, parent-assisted mail survey and a follow-up telephone interview with a subset of the mail survey respondents. The mail survey consists of a two-day food and activity diary. The telephone interviews are used to collect children's unassisted knowledge, attitudes, and beliefs about diet and exercise. A $10 cash incentive was provided to children for participating in the study. Data collection and processing were coordinated by Fleishman-Hillard Research. In total, 741 children returned the 2007 diary, and 299 completed the follow-up telephone interview, with response rates of 22 percent and 44 percent, respectively. The study was reviewed and approved by the Institutional Review Board of the Public Health Institute.

Measures

Two weight-related measures were investigated in this study. BMI *z*-scores were used as a continuous measure of BMI and overweight status (i.e., overweight or not) provided a dichotomous measure. BMI [weight (kg)/height2 (m)] was calculated from parent-reported measurements of child height and weight. Parents were asked, "What is your child's current height in feet and inches? Please measure without shoes." and "What is your child's current weight in pounds?" BMI values were converted to age- (to the nearest month) and gender-specific BMI *z*-scores (Kuczmarski et al., 2002). Overweight and obese were determined based on age- and sex-specific BMI percentiles developed in 2000 by the Center for Disease Control and Prevention (Kuczmarski et al., 2000). Updated terminology for BMI cutoff points was applied in this article (Barlow, 2007). Overweight refers to the 85th to 94th percentile, and obese describes those with a BMI at or above the 95th percentile. For assessment of the likelihood of being overweight, children in the overweight and obese groups were combined and are referred to from this point forward as overweight.

Demographic measures included age, gender, and race/ethnicity. Two socioeconomic factors were examined: parent education and household poverty status. *CalCHEEPS* defined poverty in functional terms according to household participation in the U.S. Department of Agriculture (USDA) Supplemental Nutrition Assistance Program (SNAP, formerly called the Food Stamp Program) and qualification for SNAP based on the 2007 Federal Poverty Level (FPL). Household poverty status was operationalized into four discrete categories: SNAP users (i.e., food stamp households), SNAP eligible households not receiving food stamps (i.e., $\leq$ 130% of the FPL), households potentially eligible for SNAP (i.e., > 130% to $\leq$ 185% of the FPL), and households ineligible for

SNAP (i.e., >185% of the FPL). The first three categories qualify for nutrition education and social marketing through USDA SNAP.

The food and activity diary recorded the types and number of servings of eight food groups: fruits and vegetables; whole grain breads and higher fiber cereal; dry beans; milk products; protein-rich foods; soda and sweetened beverages; high-fat snacks; and sweets. These foods were reported for each of six daily eating occasions over two consecutive school days. Serving size was semi-quantified. For PA, children reported the activity type, length of time, and intensity over three time periods (i.e., morning, afternoon, and evening) for both days. Screen time was reported using the same time frames and included time spent watching television, videos, and DVDs as well as playing video games and computer games for fun; computer time for school work was excluded. This analysis examined mean servings of fruit, juice, vegetables, fried vegetables, and high calorie, low nutrient foods including soda and sweetened beverages, high-fat snacks, and sweets reported on a typical school day. Averages were calculated by adding up each child's food and beverage servings, PA minutes, and screen time reported over both days and dividing these numbers by two. Three additional dietary practices and a measure of nutrition knowledge and skill (i.e., behavioral capability) were examined: eating school breakfast, frequency of eating school lunch, getting food from a fast food restaurant, and receiving nutrition lessons at school.

For the telephone survey, the analysis also investigated single-items measuring parent food modeling, "Your parents eat high-fat foods..."; peer food modeling, "Your friends at school usually eat healthy..."; family norms, "Your family exercises or is active together..." and "Did your family sit down and eat..."; family rules, "Your parents limit the amount of chips, soda..." and "Do your parents limit the amount of time you spend watching TV..."; and the home environment, "Do you have a television in your bedroom?"; as well as a seven-item scale developed by Saunders and colleagues (1997) that measured children's confidence to get support from others to engage in PA (i.e. support seeking self-efficacy). The complete list of variables tested, response categories, and coding is presented in Table 1. The diary, telephone interview script, and frequencies for all of the variables included in the analyses are available upon request.

Analysis

This study used exploratory regression analyses, including variables that have been identified in the literature as correlates and potential determinants of BMI, overweight, and obesity in children. The authors took an atheoretical approach to stimulate thinking about potential risk factors captured in *CalCHEEPS*. This less rigorous approach was used to facilitate discussion about the major risk factors in our data derived from a broad range of theories. Although the samples were fairly small and there was a potential for misspecification of the model, the investigators were interested in identifying the top risk factors for higher BMI and overweight status in our cross-sectional sample of children. Table 1 provides a list of the independent variables included in the regression models and indicates whether they were used in the mail or telephone survey analyses.

This was a two part analysis. The data were unweighted for the purposes of exploratory analyses, examining relationships rather than population estimates of means or proportions. First, the authors identified the primary risk factors from the independent variables identified in Table 1. Child age and gender were excluded from the models because BMI *z*-scores and the BMI percentiles for overweight were standardized for age and gender. Analyses were conducted using PASW Statistics 17.0 with its add-on regression module (SPSS Inc., 2009). Four analyses were produced using the diary and telephone samples (not presented here); two ordinary least squares (OLS) regressions with BMI *z*-scores and two logistic regressions with overweight status (i.e., overweight or not) as the dependant variables. OLS regressions used stepwise techniques. Binary logistic regressions used backward likelihood ratios. Variables were included in the models when they had a p-value $\leq .05$ and removed if they were $> .10$, except for the telephone based linear regression that used a more liberal p-value ≤ .10 to include variables and > .15 to remove them. Missing values were excluded list-wise resulting in a diary sample of 739 and 287 telephone interviews for the stepwise regressions conducted with the complete set of independent variables (Table 1) in the first analysis.

Table 1
List of All Variables Tested, by Instrument

Independent Variables	**Mail Survey (n = 739)**	**Telephone Interview (n = 287)**
Demographic and Socioeconomic Factors		
Race/Ethnicity (White, Latino, African American, and Asian/Other)	*	*
Parent Education (≤ high school for both parents [0], > high school for one parent [1], and > high school for both parents [2])	*	*
Household Poverty Status (food stamp participant, ≤ 130% FPL – no food stamps, > 130% to ≤ 185% FPL, and > 185% FPL)	*	*
Dietary Intake		
How many servings of fruit did you eat? (mean servings)	*	*
How many servings of 100% juice did you drink? (mean servings)	*	*
How many servings of fried vegetables did you eat? (mean servings)[1]	*	*
How many servings of vegetables (without fried) did you eat? (mean servings)	*	*
How many servings of each (regular soda, fruit drinks, sports drinks, and energy drinks; sweets; and high-fat snacks) did you eat/drink? (mean servings)	*	*
Physical Activity and Screen Time		
How many minutes did you spend exercising or being physically active? (mean minutes)	*	*
How many minutes did you spend watching TV/videos/DVD's or playing computer/video games for fun? (mean minutes)	*	*
Dietary Practices		
Did you eat or drink anything for breakfast?[3]	*	*
Where did you get the food for (meal/snack)? Marked fast food restaurant.[3]	*	*
How many times during a school week do you eat a lunch served by your school's cafeteria? (none [0], few times/month [1], 1-2 times/week [2], 3-4 times/week [3], and 5 times/week [4])	*	*
Behavioral Capability		
During this school year, have you had any lessons about food, nutrition, and your health?[3]	*	*
Food Modeling[2]		
Your parents eat high-fat foods like French fries, chips, or desserts.		*
Your friends usually eat healthy foods.		*
Family Norms		
Your family exercises or is active together by doing things like going to the park, playing sports, or riding bikes.[2]		*
Thinking of yesterday, did your family sit down and eat a meal together?[3]		*
Family Rules and Home Environment		
Your parents limit the amount of chips, soda, or sweets you can eat each day?[2]		*
Do your parents limit the amount of time you spend watching TV or playing video games to less than two hours a day?[3]		*
Do you have a television in your bedroom?[3]		*
Physical Activity Support Seeking Self-Efficacy[3,4]		
I think I can be physically active most days after school.		*
I think I can ask my parent/other adult to do physically active things with me.		*
I think I can ask my parent/other adult to sign me up for a sport, dance, or other physical activity.		*
I think I can ask my best friend to be physically active with me.		*
I think I can ask my parent/other adult to get me the equipment I need to be physically active.		*
I think I can ask my parent/other adult to take me to a physical activity or sport practice.		*
I think I have the skills I need to be physically active.		*

[1] This primarily includes french fries and other fried potatoes.
[2] Response options: disagree a lot [1], disagree a little [2], agree a little [3], and agree a lot [4].
[3] Response options: no [0] and yes [1]. Nutrition lessons are coded: yes [1] and no [2].
[4] This was a seven-point additive scale based on the responses from each item.
Italicized variables were used in the final models.

Second, the primary risk factors identified in the first analyses were simultaneously entered into OLS or logistic regressions controlling for race/ethnicity. Four additional analyses were produced using the diary and telephone samples: two OLS regressions with BMI *z*-scores and two logistic regressions with overweight status as the dependant variables. The simultaneous models had list-wise, non-missing samples of 741 (diary) and 299 (telephone). The OLS

Table 2
Sample Descriptions (Unweighted)

	Mail Survey (n = 741)		**Telephone Interview (n = 299)**	
	n	**Percent**	**n**	**Percent**
Overweight Status				
Not Overweight: BMI < 85th percentile	469	63.3	190	63.5
Overweight: BMI ≥ 85th percentile - < 95th percentile	115	15.5	46	15.4
Obese: BMI ≥ 95th percentile	157	21.2	63	21.1
Gender				
Boy	362	48.9	143	47.8
Girl	379	51.1	156	52.2
Age				
9 Years	206	27.8	72	24.1
10 Years	390	52.6	173	57.9
11 Years	145	19.6	54	18.1
Race/Ethnicity				
White	374	50.5	168	56.2
Latino	184	24.8	72	24.1
African American	62	8.4	22	7.4
Asian/Other	121	16.3	37	12.4
Parent Education				
≤ High School for Both Parents	136	18.4	49	16.4
> High School for One Parent	313	42.2	122	40.8
> High School for Both Parents	292	39.4	128	42.8
Nutrition Lessons				
Yes	423	57.1	178	59.5
No	318	42.9	121	40.5
Times Eating School Lunch				
None	123	16.6	59	19.7
Few Times/Month	90	12.1	42	14.0
1-2 Times/Week	110	14.8	42	14.0
3-4 Times/Week	75	10.1	25	8.4
5 Times/Week	343	46.3	131	43.8
Television in Bedroom				
Yes			163	54.5
No			136	45.5
Parent Eat High-Fat Foods				
Disagree a lot			100	33.4
Disagree a little			68	22.7
Agree a little			97	32.4
Agree a lot			34	11.4
	n	**Mean**	**n**	**Mean**
BMI *z*-score	741	.608	299	.594
Servings of Fried Vegetables	741	.171	299	.145
Minutes of Physical Activity	741	82.6	299	86.8

Gray boxes indicate that the question is not present on the survey.

Regression Model 1 (ORM1) provided the coefficients for continuous BMI *z*-scores adjusting for race/ethnicity; the Logistic Regression Model 1 (LRM1) presented the odds ratios for overweight status adjusting for race/ethnicity. The OLS Regression Model 2 (ORM2) and Logistic Regression Model 2 (LRM2) added to the basic models by introducing the remaining risk factors. Models were compared for improvement in R^2 or -2 log likelihood as the additional block of variables was added.

Results

Table 2 describes the study samples for the mail and telephone surveys. Approximately half of the subjects were girls. Ages ranged from 9 to 11 years with an average of 9.9 years ± 0.683. The primary race/ethnic groups were White and Latino; African American and Asian/Other were also examined. Four out of five children came from homes where one or both parents received education beyond high school. On average, children reported eating less than a quarter of a serving of fried vegetables and spent nearly one and a half hours engaging in PA on a typical school day. Three out of five had access to nutrition lessons at school. Almost half ate school lunch daily. Over half reported having a television in their bedroom. Two out of five agreed that their parents ate high-fat foods. Over one-third of the children surveyed were overweight, and of these nearly three out of five were obese. *CalCHEEPS* data underrepresented Latino children and families ineligible for SNAP, and it overrepresented White children and families using food stamps (U.S. Census Bureau, 2007).

Table 3 presents results from the diary regression models adjusting for race/ethnicity. In ORM1 and LRM1 (controlled for race/ethnicity), race/ethnicity was not associated with BMI *z*-scores or overweight. With the addition of parent education, fried vegetable consumption, and times eating school lunch into ORM2 and LRM2 (added risk factors), parent education was strongly associated with both BMI *z*-scores and overweight among diary respondents. More parent education was associated with a lower BMI *z*-score (B=-.266; p<.001) and a reduced likelihood of being overweight (OR=.657; p<.001). In addition, consumption of fried vegetables was associated with a higher BMI *z*-score (B=.339; p<.05). Children who ate school lunch more often had an increased likelihood of being overweight (OR=1.172; p<.01).

Table 4 presents results from the regression models of children who completed the telephone interview adjusting for race/ethnicity. In ORM1 (controlled for race/ethnicity), race/ethnicity was associated with BMI *z*-scores (p<.05). Specifically, Latino and African American children had higher BMI *z*-scores (B=.362; p<.05 and B=.813; p<.01) when compared to White children. However, with the entry of parent education, times eating school lunch, television in the bedroom, nutrition lessons, parents modeling high-fat food consumption, and minutes of PA into OLRM2 (added risk factors), these relationships were no longer significant. When examining LRM1 (controlled for race/ethnicity), race/ethnicity was not associated with overweight. In ORM2 and LRM2 (added risk factors), parent education was associated with both BMI *z*-scores and overweight among phone survey respondents. More parent education was associated with a lower BMI *z*-score (B=-.305; p<.01) and a reduced likelihood of being overweight (OR=.633; p<.05). When examining the remaining five variables (i.e., times eating school lunch, television in the bedroom, nutrition lessons, parents modeling high-fat food consumption, and minutes of PA) in LRM2 (added risk factors), children who ate school lunch more often had an increased likelihood of being overweight (OR=1.319; p<.01). None of these five remaining variables were significantly associated with BMI *z*-scores in ORM2 (added risk factors).

Discussion

Summary of the Findings

This study used *CalCHEEPS* data to explore self-reported socioeconomic, psychosocial,

Table 3
Risk Factors for Childhood Overweight, Diary (Mail Survey)

	OLS Regression: Continuous BMI *z*-Scores (n = 741)				**Logistic Regression: Likelihood of Overweight[1] (n = 741)**					
	Model 1 (ORM1): Controlled for Race/Ethnicity		**Model 2 (ORM2): Added Risk Factors**		**Model 1 (LRM1): Controlled for Race/Ethnicity**			**Model 2 (LRM2): Added Risk Factors**		
	Coeff.	***(SE)***	***Coeff.***	***(SE)***	***Coeff.***	***(SE)***	***OR***	***Coeff.***	***(SE)***	***OR***
Constant	*.532 ****	*(.067)*	*.735 ****	*(.142)*	*-.713 ****	*(.110)*	*.490*	*-.675 ***	*(.237)*	*.509*
Explanatory Variables										
Race/Ethnicity[2]	ns		ns		ns			ns		
Parent Education			-.266 ***	(.068)				-.420 ***	(.112)	.657
Servings of Fried Vegetables			.339 *	(.133)				.345	(.216)	1.412
Times Eating School Lunch			.025	(.032)				.158 **	(.055)	1.172
Model Fit										
R-Square	.009		.046***							
Change in R-Square	.009		.037***							
Nagelkerke R-Square					.014			.076		
Cox & Snell R-Square					.010			.055		

[1] Overweight includes children with a BMI at or above the 85th percentile.
[2] Race/ethnicity entered as a block. The F test (OLS Regression) and Wald test (Logistic Regression) were used to obtain the p-values for the global tests of race/ethnicity in each model. No significance was found for race/ethnicity (ns = not significant).
* p < .05, ** p < .01, *** p < .001.
OLS = ordinary least squares, SE = standard error, OR = odds ratio

Table 4
Risk Factors for Childhood Overweight, Telephone Interview

	OLS Regression: Continuous BMI *z*-Scores (n = 299)				**Logistic Regression: Likelihood of Overweight[1] (n = 299)**					
	Model 1 (ORM1): Controlled for Race/Ethnicity		**Model 2 (ORM2): Added Risk Factors**		**Model 1 (LRM1): Controlled for Race/Ethnicity**			**Model 2 (LRM2): Added Risk Factors**		
	Coeff.	***(SE)***	***Coeff.***	***(SE)***	***Coeff.***	***(SE)***	***OR***	***Coeff.***	***(SE)***	***OR***
Constant	*.422 ****	*(.096)*	*.737 **	*(.341)*	*-.802*	*(.167)*	*.448*	*-.946*	*(.622)*	*.388*
Explanatory Variables										
Race/Ethnicity Subgroup[2]	*		ns		ns			ns		
White (reference)	ref		ref							
Latino	.362 *	(.174)	.207	(.174)						
African American	.813 **	(.281)	.529	(.281)						
Asian/Other	.202	(.225)	.216	(.221)						
Parent Education			-.305 **	(.105)				-.457 *	(.189)	.633
Times Eating School Lunch			.050	(.048)				.277 **	(.091)	1.319
Television in Bedroom			.268	(.154)				.272	(.283)	1.313
Nutrition Lessons			.191	(.144)				.363	(.260)	1.438
Parents Eat High-Fat Foods			-.114	(.070)				-.208	(.129)	.812
Minutes of Physical Activity			-.002	(.001)				-.001	(.002)	.999
Model Fit										
R-Square	.036*		.111***							
Change in R-Square	.036*		.075***							
Nagelkerke R Square					.025			.152		
Cox & Snell R-Sqaure					.018			.111		

[1] Overweight includes children with a BMI at or above the 85th percentile.
[2] Race/ethnicity entered as a block. The F test (OLS Regression) and Wald test (Logistic Regression) were used to obtain the p-values for the global tests of race/ethnicity in each model. No significance was found for race/ethnicity (ns = not significant).
* p < .05, ** p < .01, *** p < .001.
OLS = ordinary least squares, SE = standard error, OR = odds ratio

behavioral, and environmental factors related to childhood overweight with the ultimate purpose of identifying the direct risk factors for higher BMI and overweight among 9- to 11-year-old children. When examining socioeconomic factors, parent education was strongly related to both BMI and overweight; poverty status was not. Of the psychosocial factors reported by the children, including behavioral capability (i.e., nutrition lessons), parent and peer food modeling, and confidence to get support from others to engage in PA (i.e., support seeking self-efficacy), none were significantly associated with children's BMI or overweight.

In contrast, one measure of dietary intake (i.e., servings of fried vegetables) was identified as a risk factor for higher BMI, and one dietary practice (i.e., eating school lunch) was found to be a risk factor for childhood overweight. Other measures of dietary intake (i.e., fruit, 100% juice, vegetable, and high calorie, low nutrient food consumption) and dietary practices (i.e., eating breakfast and getting food from a fast food restaurant) were unrelated to BMI and overweight. No significant relationships were observed for mean minutes of PA, screen time, or the environmental factors examined in this study (i.e., family exercises together, family meals, limits on high calorie low, nutrient food and screen time, and having a television in the bedroom).

Parent education was the strongest risk factor for child BMI and overweight in both the diary and telephone interview samples. Higher BMI and likelihood of overweight were most common among children whose parents had less education with a clear gradient towards reduction in one's risk as parent education improved. For the three levels of parent education examined (i.e., both parents with a high school education or less, one parent with higher education, and both parents with higher education), children were .3 BMI *z*-score points lower and one-third less likely to be overweight at each increasing level of parent education. This is comparable to what Rose and Bodor (2006) found for maternal education: children were nearly one-third less likely to be overweight if their mother's were college graduates compared to those with a mother who graduate from high school. Singh and colleagues (2008) also demonstrated the influence of parent education, finding that children whose parents had a high school education or less had 42 percent higher odds of being obese than children with college-educated parents. These findings indicate a critical need for overweight prevention efforts among children with parents that have a high school education or less.

In this analysis, parent education appeared to be a more important risk factor for child BMI and overweight than race/ethnicity or household poverty status. Race/ethnicity was only a significant risk factor in one of the four models examined, and this relationship was not present after the addition of parent education. Poverty status was a strong risk factor for BMI and overweight if parent education was omitted from the analyses (analyses not presented here). However, when parent education was entered into the regression models, household poverty no longer remained significant. This indicates, as one would assume, that the two variables are closely related, but in this study parent education was the direct risk factor for child BMI and overweight. Bhargava and colleagues (2008) also found that lower parent education related to higher body weight among children, while household food security was not a significant predictor. However, several other studies have demonstrated the explanatory value of poverty level and ethnicity (Rose & Bodor, 2006; Singh et al., 2008; Wang & Zhang, 2006), showing that a lower poverty index as well as African American and Latino ethnic groups were significantly related to an increased likelihood of being obese. One explanation is provided by evidence from a geographic analysis of poverty and overweight by California assembly districts, which suggests greater clustering of poverty and childhood overweight among the African American and Latino populations; parent education was not explored in this analysis (Drewnowski et al., 2009). Overall, these studies show that the relationships between race/ethnicity, poverty, parent education, and overweight are extremely complex and confirm that each of these factors should be taken into consideration when estimating risk for childhood overweight.

This study expanded upon much of the work in this field by incorporating dietary intake with other commonly examined risk factors (Gordon-Larsen, Adair, & Popkin, 2003; Rose & Bodor, 2006; Singh et al., 2008). Among the dietary measures included, consumption of fried vegetables was significantly related to BMI. Each serving of fried vegetables reported was associated with more than a .3 point increase in BMI *z*-score. Although the relationships between fried foods and other energy-dense foods have shown associations with BMI and overweight (Epstein, Paluch, Beecher, & Roemmich, 2008; Johnson et al., 2008), to our knowledge the specific contribution of eating fried vegetables has not been investigated. However, one study did show that offering french fries and similar potato products in school meals more than once per week was associated with a higher likelihood of obesity among elementary school children (Fox et al., 2009). This provides a potential direct indicator for child BMI and warrants additional exploration.

Eating school lunch was identified as a risk factor for overweight in both the diary and telephone interview samples with a clear gradient towards increased risk as children ate school lunch more often. Children were 1.2-1.3 times more likely to be overweight with each increase in their weekly school lunch participation (i.e., none, few times/month, 1-2 times/week, 3-4 times/week, and 5 times/week). Studies about the relationship between eating school lunch and overweight are mixed. Li and Hooker (2010) found that children taking part in the National School Lunch Program (NSLP) or the School Breakfast Program (SBP) had a 4.5 percent higher probability of being overweight than non participants. Another study investigating participation in all three food assistance programs (i.e., SNAP, NSLP, and SBP) showed that food insecure girls had a 68 percent reduced odds of being overweight compared to food insecure girls in non participating households; no difference was observed for boys (Jones, Jahns, Laraia, & Haughton, 2003). Bhargava and colleagues (2008) explored SNAP and NSLP participation as independent risk factors and found that children from households using SNAP were significantly lighter compared to non users, whereas children receiving free school lunch weighed significantly more than those not getting free lunch. Authors added poverty status to the final simultaneous regression models examined in this study and the relationship did not change, indicating that the association between eating school lunch and overweight was observed in all children regardless of household poverty level. This evidence suggests that the foods provided as part of the NSLP be examined closely to ensure that they do not contribute to weight gain among children. Children who receive free or reduced price school meals may be disproportionately impacted by the nutritional quality of food served in school cafeterias.

Several of the variables (i.e., having a television in the bedroom, access to nutrition lessons, parent modeling, and minutes of PA) included in the final telephone regression models were not significantly related to child BMI or overweight. Refining these measures may improve their predictive value. Other studies have shown evidence regarding the association between television in the bedroom and BMI (Adachi-Mejia et al., 2007; Delmas et al., 2007), although they did not examine potential dietary or environmental factors. Examining the presence of a television in the bedroom in conjunction with time spent watching the television may be more effective. Self-reported access to “any” nutrition education may also be too crude of a measure on its own; examining the frequency and length of nutrition lessons may show more promise. For parent modeling, using a set of family characteristics incorporating family norms, rules, and the home environment similar to the obesigenic family operationalized by Davison and Birch (2002) may provide a stronger risk factor. Research has shown a significant relationship between PA and overweight when incorporating the intensity, with higher levels of vigorous PA related to lower BMI and reduced likelihood of obesity (Patrick et al., 2004; Wang et al., 2007; Wittmeier et al., 2008). Total time spent being physically active may need to be examined together with PA intensity when investigating risk factors for childhood overweight.

Limitations

Multiple limitations should be noted. Cross-sectional surveys cannot infer causality. Based on the small survey samples, only the most influential risk factors could be identified in this study. The sample of African American children was small and may not be generalizable to the population at large. The Latino households that took part in the study were English-speaking, under representing children from households in which Spanish was the primary language spoken at home who, along with African American children, are more likely to live in poverty (The Henry J. Kaiser Family Foundation, 2009). Data collected were self-reported by the children, which could be inaccurate or biased in the direction of social desirability. While *CalCHEEPS* uses an unassisted telephone interview to reduce parental influence on attitudes and beliefs, children may be reluctant to report attitudes and behaviors regarding diet and PA that diverge from their parents (Klesges et al., 2004). The parent-assisted food and exercise diary, which was utilized to improve the accuracy of child reporting, also could have been subject to social desirability. Compared to measured data, parent-reported height and weight overestimate childhood overweight; the discrepancy primarily results from underreporting height (Akinbami & Ogden, 2009).

The food and activity diary was complex and lengthy, resulting in a low response rate which raises concern that the findings may not be generalizeable to the population at large. Comparisons between families who filled out the diary and those who refused showed that families participating in *CalCHEEPS* were more likely to: have a household income of $75,000 or more, be married, be White, be age 40 or over, have a college degree or higher, and be employed full time. Market-research panel households provide a "best-case" sample of 9- to 11-year-old children because they are accessible over time, interested in research, and willing to complete the surveys. During weekdays, children's schedules are more structured, many are likely to eat school meals, and dietary choices tend to be lower in snacks and fast foods (Haines, Hama, Guilkey, & Popkin, 2003). Only English-speaking households were included, so families using other languages were not represented.

Implications

This study identified three risk factors for child BMI and overweight that may be addressed by parents, schools, and through other public health approaches. Overweight prevention initiatives and interventions must target children whose parents have less education, which was the chief risk factor for child BMI and overweight. When addressing dietary intake and practices, public health and nutrition education professionals can incorporate strategies that encourage children to eat more fruits and vegetables, while also reducing the consumption of fried vegetables such as french fries. Working with schools to buy, prepare, and serve nutritious foods that children like will improve prevention efforts aimed at childhood overweight, particularly among low-income children who tend to consume school meals most often.

Low-income and minority children tend to have a lower diet quality (P. Gleason, Rangarajan, & Olson, 2000), are less physically active (Crespo et al., 2001; Pate et al., 1997), watch more television (Crespo et al., 2001; Roberts, Foehr, Rideout, & Brodie, 2004), are more likely to have a television in their bedroom (California Department of Public Health, 2009), and are less likely to report access to nutrition education compared to others (California Department of Public Health, 2009). This places ethnically diverse children from low-income families at a significantly higher risk of overweight and highlights the critical need for low-cost prevention efforts specifically targeted to this population.

Collaborative, multilevel, evidence-based public health approaches can help prevent childhood overweight (Koplan et al., 2005). The *Network for a Healthy California's* nutrition education efforts such as the *California Children's Power Play! Campaign* and *Harvest of the Month* can integrate the strategies outlined above into a strong statewide infrastructure reaching large numbers of low-income families. Schools also play a critical role by feeding large numbers of children in the U.S. Annually, 31.2 million children participated in the NSLP, and out of these children nearly two-thirds received free or reduced price lunches (Food Research and Action Center, 2009).

Further research is needed to clarify the relationship between frequency of eating school lunch and the likelihood of overweight among children. Additional investigation of the specific types and quantities of foods consumed as part of the school lunch and any associations with childhood overweight would provide useful insight. Replicating the study across survey years, with different populations, and pooling multiple years of data are needed to examine the consistency and robust nature of these findings and highlight additional risk factors that show up in a larger sample.

Acknowledgements

The authors wish to recognize participating *Network for a Healthy California* staff including Jennifer Gregson, M.P.H., Ph.D., for writing and editing assistance and Evan Talmage, B.A., for reviewing the literature. We would also like to express our appreciation to Mark Hudes, Ph.D., for statistical consultation.

This material was produced by CDPH *Network for a Healthy California* with funding from USDA SNAP and CDPH. These institutions are equal opportunity providers and employers. The California Food Stamp Program provides assistance to low-income households, and it can help buy nutritious foods for better health. For food stamp information, call 1-877-847-3663. For important nutrition information, visit www.cachampionsforchange.net.

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