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Double Trouble: Commingled Effects of Fast Food and Sugar-Sweetened Beverage Consumption and the Intervening Role of Physical Activity on Childhood Obesity[†]

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Abstract – Children are exposed to a great deal of food and beverage promotion. This is particularly concerning given that the prevalence of childhood obesity, a critical public health challenge, may be partially due to the increased consumption of fast food and sugar-sweetened beverages. However, there are lingering questions about the complex relationships between fast food and sugar-sweetened beverage consumption, physical activity levels, and childhood obesity. To address these complex relationships, this research examines the interaction of fast food and sugar-sweetened beverage consumption, along with the frequency of physical activity, in leading to the likelihood of a child being overweight or obese. A primary concern is the compensatory role of physical activity in offsetting the direct and indirect effects of fast food and sugar-sweetened beverage consumption on childhood obesity. For a sample of more than 4000 children between five and eleven years of age, results show that physical activity can partially counter the direct relationship between (1) fast food consumption and obesity and (2) sugar-sweetened beverage consumption and obesity. However, this intervening role of physical activity indicates that activity level is unable to compensate for the combined effect of high fast food and high sugar-sweetened drink consumption on obesity likelihood. Conclusions for the public health

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community and possible implications for policy makers interested in the combined roles of fast food and sugar-sweetened drink consumption on childhood health and obesity are offered.

Keywords – Consumption, Fast food, Obesity, Physical activity, Sugar-sweetened Beverages

Relevance to Marketing Educators, Researchers, and Practitioners – Results have potential implications for marketers, the public health community, and policy makers interested in interventions to diminish the roles of fast food and sugar-sweetened drink consumption in efforts to improve childhood health through reductions in obesity.

Introduction

According to the World Health Organization (WHO), the high prevalence of childhood obesity is one of the most serious public health challenges of the 21st century (WHO, 2012). Approximately one-third of American children and teenagers are overweight or obese (Ogden et al, 2014; WHO, 2012). These children are likely to remain overweight and obese when they enter adulthood and will face a significantly higher risk of cardiovascular disease due to an increase in risk factors such as type 2 diabetes, high blood pressure, and high cholesterol (CDC, 2012; Goran, Ball, and Cruz, 2003). As the prevalence of childhood obesity increased over the past three decades, so has fast food and sugar-sweetened drink consumption. One-third of children eat fast food on a daily basis, and 91% of children between the ages of 6 and 11 consume sugar-sweetened beverages daily (Bowman et al, 2004; Lasater, Piernas, and Popkin, 2001).

Some have suggested that a failure to compensate for the high number of empty calories found in fast food and sugar-sweetened drinks is a significant contributing factor in the development of obesity (WHO, 2012). Empty calories come from high fat and sugar-laden foods and beverages with few or no beneficial nutrients. Children may be able to compensate for some, but not all, sweetened beverage and fast food consumption with increased daily physical activity. This research addresses the compensatory role of physical activity in offsetting the direct and indirect effects of fast food and sugar-sweetened beverage consumption on childhood obesity.

Purchases of food outside the home account for almost one-half of Americans' total annual food expenditures (USDA, 2015). Currently, over 160,000 fast food restaurants in the United States serve over 50 million consumers each day (Pew Research Center, 2015). The fast food restaurant industry has been criticized for heavily targeting children with a myriad of promotional activities and marketing both foods and entire meals that are high in calories and sold in excessively large servings (Seiders and Petty, 2004; 2007). A recent study reported that the fast food industry spent $4.6 billion on advertising to children in 2012 (Yale Rudd Center for Food Policy and Obesity, 2013). Furthermore, the number of children that eat fast food on a daily basis has increased more than fivefold since 1970, and today one in three children eat fast food daily (Bowman et al 2004; Rehm and Drewnowski, 2015). Given that fast food typically has an adverse effect on dietary quality, this may partially account for the increased level of childhood obesity prevalence. In fact, children who eat fast food consume an average of almost 200 more calories per day than children who do not (Bowman et al, 2004). These facts make the need for a more complete understanding of the direct and indirect effects of fast food consumption on childhood obesity clear.

In addition to the concerns associated with fast food consumption, there also has been increasing worry about the role of sugar-sweetened beverages in childhood obesity. Children and

teens are almost constantly exposed to promotional messages for sugar-sweetened beverages (Harvard School of Public Health, 2012), and many children are offered sugar-sweetened beverages through distribution channels involving schools (e.g., vending machines; Seiders and Petty, 2004). In addition, over the past five decades, there has been an increase in soft drink serving sizes (Harvard School of Public Health, 2015). Prior to the 1950s, a standard soft-drink bottle was 6½ ounces. However, by the early 1960s, the 12-ounce can or bottle was the default size. In the 1990s, 20-ounce plastic bottles, containing approximately the equivalent of 16 teaspoons of sugar (about 130% of the daily maximum amount according to FDA recommendations), became commonplace. In addition, many convenience stores serve extra-large fountain drink sizes that can contain up to 700 calories.

Not surprisingly, sugar-sweetened beverages (including sodas, energy, and sports drinks) are the single top source of calories in teens' diets (i.e., 226 calories per day; Harvard School of Public Health, 2015). The average number of calories consumed from these beverages per day is even higher among adolescent boys in the United States (Wang, Bleich, and Gortmaker, 2008). Given the number of empty calories coming from these beverages, it is not surprising that the recent increase in consumption of sugar-sweetened beverages among children (and adults) is considered by some critics to be a major contributor to the obesity epidemic (Caprio, 2012; Ludwig, Peterson, and Gortmaker, 2001; Malik, Popkin, Bray, Després, and Hu, 2010). Thus, reducing children's consumption of sodas and other sugar-laden beverages potentially can help with weight control (Harvard School of Public Health, 2015; USDHHS, 2015).

Conceptual Rationale

Body weight increases are associated with an imbalance of the energy content of food and beverage consumption and the energy expended by the body to maintain life, perform physical work, and exercise. When such consumption leads to an intake of calories that exceeds the output of energy expended over time, weight gain occurs. It is well-understood that in addition to reducing energy input through healthy eating habits, physical activity increases energy output and can lower the risk of becoming obese and developing related diseases (USDHHS, 2015).

Based on this fundamental metabolic principle, we predict that a fast food consumption and sugar-sweetened beverage consumption are positively related to an overweight or obese weight status. However, we also predict an interactive effect of fast food and sugar-sweetened beverage consumption. Specifically, we propose that the frequency of fast food consumption will have a stronger, positive effect on overweight / obese likelihood for those drinking fewer sugar-laden beverages. Given that sugar-sweetened drink consumption should have a substantial, positive association obesity among young consumers (Harvard School of Public Health, 2015; Ludwig, Peterson, and Gortmaker, 2001), those consuming a relatively high number of sugar-sweetened drinks should already be more likely to be overweight or obese. Thus, with *less* frequent sugar-sweetened beverage consumption, the incremental effect of the added calories from frequent fast food consumption should be strengthened and more evident. Predictions for these direct and interactive effects of fast food and sugar-sweetened beverage consumption are offered in H1 and H2 below.

H1: Consumption of (a) fast food and (b) sugar-sweetened beverages is positively related to a child's likelihood of being overweight or obese.

H2: Consumption of fast food and sugar-sweetened beverages interact to influence the likelihood that a child is overweight or obese. While lower (higher) consumption of both fast food and sugar-sweetened beverages is related to a lower (higher) likelihood of being overweight or obese, the positive effect of fast food consumption on the likelihood of being overweight or obese should be greater when sugar-sweetened beverage consumption is low.

Consistent with past findings, because greater physical activity levels burn calories, the amount of physical activity is negatively related to a child's likelihood of being overweight or obese (H3). Thus, at least at some level, physical exercise and activity levels will help compensate for the calories associated with consumption of fast food and sugar-sweetened beverages. This negative and compensatory role of physical activity suggests an intervening relationship in which activity level will at least partially account for the effects of fast food and sugar-sweetened beverage consumption on the likelihood of an unhealthy (i.e., overweight or obese) weight status.

However, we also propose that this compensatory and intervening role of physical activity level is not consistent across the combinations of fast food and sugar-sweetened beverage consumption levels. Generally, we propose that there are limits to the degree to which physical activity can compensate for high levels of both fast food and sugar-sweetened drinks. When consumption of both fast food and sugar-sweetened drinks are at higher levels, the calories burned from physical activity become less likely to be sufficient to compensate for the calories related to children's consumption behavior. Thus, when sugar-sweetened beverage consumption is low, physical activity is proposed to more strongly compensate and mediate the effect on the likelihood of being overweight or obese. Yet, this intervening role of physical activity for the fast food → overweight / obese relationship should be attenuated when sugary beverage consumption is high. Hypotheses related to the role of physical activity are offered below (H3-H5).

H3: Physical activity levels are negatively related to childhood overweight / obese status.

H4: Physical activity levels mediate the direct effects of (a) fast food and (b) sugar-sweetened drinks on childhood overweight / obese status.

H5: There is a conditional mediation effect for physical activity level. When sugar-sweetened drink consumption is low, physical activity mediates the effect of fast food consumption on overweight / obesity likelihood, but when sugar-sweetened drink consumption is high, the mediation effect is attenuated.

Methods

Sample and Procedure

Data used to test predictions are from the California Health Interview Survey (CHIS), a random-dial telephone survey that queries Californians on a wide range of health topics conducted between June 2011 and January 2013 (UCLA Center for Health Policy Research, 2014). CHIS is conducted on a continuous basis and uses a multistage sampling method, with oversampling of smaller ethnic groups. Greater detail on the methodology involved in data collection can be found online (UCLA Center for Health Policy Research, 2014). For this research, we focus on elementary school-aged children (i.e., ages 5 to 11). The adult member of the family with the greatest knowledge of the child's health answered the survey questions. Response rates were within acceptable levels; screener response rates were 31.6% for the landline sample and 33%

for the cell phone sample. The response rates for the extended interview for the landline and cell samples were 73.2% and 73.4%, respectively. There were 4087 respondents in the sample used to test predictions.

Measures

The binary dependent variable was whether the child was overweight or obese (overweight or obese = 1) or normal weight or underweight (normal weight or underweight = 0). The main independent variables were: (1) the number of fast food meals consumed during the past week (i.e., "In the past 7 days, how many times did {he/she} eat fast food? Include fast food meals eaten at school or at home, or at fast food restaurants, carryout, or drive thru") and (2) the number of sodas and sugar-sweetened drinks consumed the previous day (i.e., "Yesterday, how many glasses or cans of soda, such as Coke, or other sweetened drinks, such as fruit punch or sports drinks did {he/she} drink? Do not count diet drinks"). Consistent with recommendations for physical activity for children (USDHHS, 2015), the measure was an open-ended question that asked the number of days the child was physically active for at least 60 minutes during the past week (ranging from 0 to 7 days). Control variables included the child's age in years, gender (0 = male; 1 = female), and race (0= non-white; 1 = white).

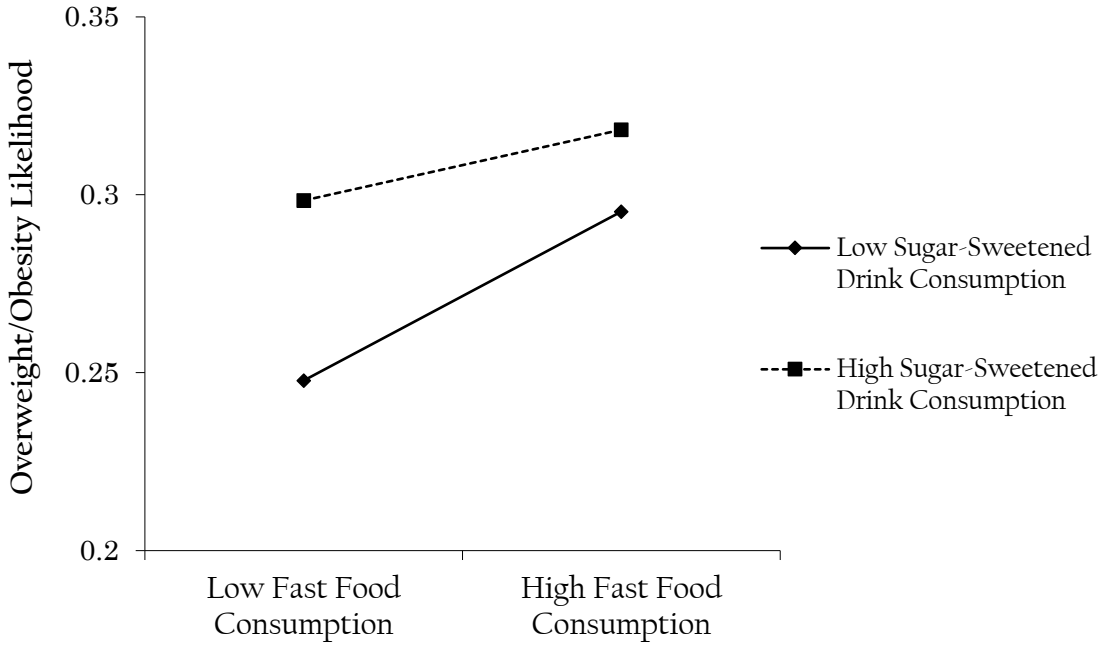
Results

We used Model 1 in the PROCESS algorithm to test the hypotheses for the proposed influence of fast food and sugar-sweetened beverage consumption on overweight / obese status (Hayes, 2013). Prior to creating the fast food consumption by sugar-sweetened beverage consumption interaction, the variables were centered at their means. The likelihood of being overweight / obese was regressed on fast food consumption, sugar-sweetened beverage consumption, fast food consumption by sugar-sweetened beverage consumption interaction, and the control variables. Each of the control variables had a significant influence on overweight / obesity likelihood (race: $b = -.31$, $p < .001$; gender: $b = -.19$, $p < .01$; age: $b = -.14$, $p < .001$).

As predicted, the results support H1 and H1b; consumption of both fast food and sugar-sweetened drinks were positively related to the likelihood of being overweight / obese (ps < .01). As consumption increased, the likelihood of being in the overweight / obese category increased (fast food consumption: $b = .07$, $z = 2.67$, $p < .01$; sugar-sweetened drink consumption: $b = .17$, $z = 3.37$, $p < .001$). However, the interaction effect of fast food and sugar-sweetened drink consumption on obese/overweight likelihood was negative and significant ($b = -.05$, $z = 1.65$, $p < .05$). A plot of the interaction is shown in Figure 1. As shown in Figure 1, the effect of fast food consumption frequency on whether or not a child is likely to be overweight / obese was positive when sugar-sweetened drink consumption was at low levels (no consumption: $b = .09$, $z = 2.92$, $p < .01$). However, this positive effect of fast food consumption was nonsignificant when sugar-sweetened drink consumption was at high levels (i.e., one standard deviation above the mean consumption level; $b = .03$, $z = 1.14$, $p > .25$). In addition, as would be expected, the predicted values for overweight / obese likelihood were highest (lowest) when both fast food and sugar-sweetened drink consumption were high (low). These interaction effects support H2.

Figure 1

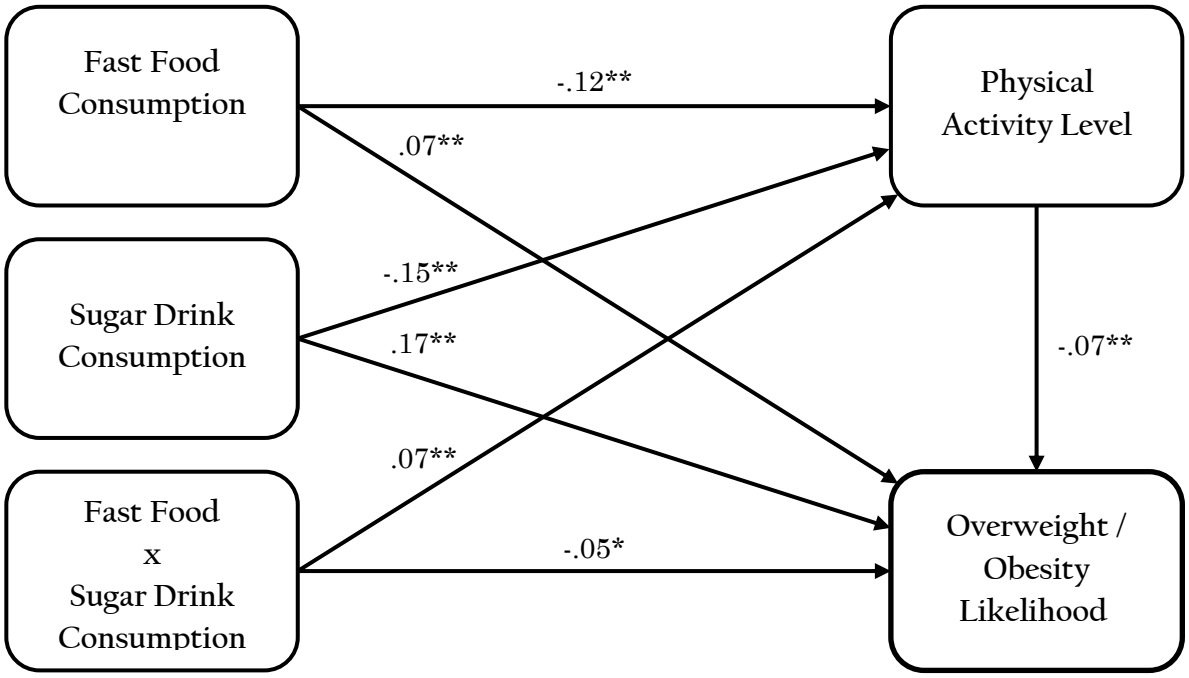
The Effect of Fast Food and Sugar-Sweetened Drink Consumption on Childhood Obesity



A primary focus of the research is on the intervening, compensatory role of physical activity hypothesized in H3 to H5. To test H3 and H4, we used Model 4 of the PROCESS algorithm (Hayes, 2013). Again, race, gender, and age were entered into the model as control variables. Supporting H3 and consistent with the calorie input-output model, there was a negative relationship between physical activity and the likelihood of being overweight / obese (b = -.07, z = 4.76, p < .001). In addition, there was a significant negative relationship between fast food consumption and physical activity frequency. These paths, both to and from physical activity frequency, suggest the intervening role of exercise. Results show that there was an indirect effect for fast food consumption → physical activity → overweight / obesity likelihood (Indirect effect (IE) = .01, 95% bias-corrected bootstrap confidence interval (CI) [.002, .01]). However, the positive indirect effect for sugar-sweetened beverage consumption → physical activity → overweight / obesity likelihood was not significant (CI [-.01, .01]).

Figure 2

The Direct and Indirect Effects of Fast Food and Sugar-Sweetened Drink Consumption on Childhood Obesity



Note: Although not shown in Figure 2, this conditional mediation model included age, gender, and race as control variables.

$p < .05$*; $p < .01$**

Given the predicted effect of the fast food by sugar-sweetened drink interaction on weight status, H5 predicted conditional (moderated) mediation for the role of physical activity in compensating for the consumption effects. This hypothesis was tested using Model 8 of the PROCESS algorithm (Hayes, 2013). Again, race, gender, and age were entered into the model as control variables. An overview of these results is shown in Figure 2. Results show that the extent to which physical activity mediates the relationship between fast food consumption and the likelihood of being overweight / obese is dependent on sugar-sweetened drink consumption. There was a significant intervening role of physical activity when sugar-sweetened drink consumption was at low levels (no consumption: IE = -.01, CI [.003, .01]). In this case, physical activity partially accounted for the positive relationship between fast food consumption and the child's weight status. However, when sugar-sweetened drink consumption was high (one standard deviation above the mean consumption level), the indirect effect of fast food consumption through physical activity on overweight / obesity likelihood was nonsignificant (CI [-.001, .01]). This indicates that when there is a high level of sugar-sweetened drink consumption, physical activity is not able to compensate for the positive effects of higher fast food consumption on children's likelihood of being overweight or obese. These results support H5.

Discussion

There has been much debate pertaining to the marketing of food to children and the implications of these marketing practices for childhood obesity (see Seiders and Petty 2007). For example, prior studies have examined television advertising and online food marketing targeting children (Desrochers and Holt 2007; Moore and Rideout 2007), the influence of ethnically targeted promotion and distribution on children's fast food consumption (Grier et al, 2007), and the influence of the retail environment and fast food restaurant concentration on childhood obesity (Howlett, Davis, and Burton 2016; Newman, Howlett, and Burton 2014). This research adds to this important literature by examining the complex relationships between children's fast food consumption, sugar-sweetened beverage consumption, physical activity, and the likelihood of a child being overweight or obese.

Findings from this research indicate that fast food and sugar-sweetened beverage consumption are positively related to the likelihood of a child being either overweight or obese. There are many well-documented economic and societal consequences associated with the dramatic increase in childhood obesity. When comparing lifetime medical costs to those of a normal weight child, childhood obesity leads to an increase of $19,000 per child. Given the number of obese 10-year-olds in the United States today, projected medical costs over the lifetime for this specific age alone approaches $14 billion (Finkelstein, Graham, and Malhotra, 2014). Understanding the extent to which specific consumption behaviors (i.e., the combination of fast food and sugar-sweetened beverages) are related to childhood overweight / obesity status, and how this combined consumption can be counterbalanced through physical exercise, has important implications for the health of current and future generations.

Consistent with prior research, fast food and sugar-sweetened drink consumption are positively related to increases in the likelihood of a child's being overweight or obese. However, results also show a negative and significant fast food by sugar-sweetened beverage interaction. As shown in Figure 1, the fast food by sugar-sweetened beverage consumption interaction suggests that the impact of fast food consumption on overweight / obese status is stronger when children consume sugar-sweetened beverages less frequently. However, as would be anticipated, there is a "double-barreled" effect for high levels of fast food and sugar-sweetened beverage consumption. Higher dual consumption levels lead to a greater predicted likelihood of a child being either overweight or obese. Based on the energy input-output model for nutrition and consumers' weight, we predicted an intervening role of physical activity (i.e., greater activity helps to counteract the individual direct effects of fast food and sugar-sweetened beverage consumption), but that the effect of the role of activity would differ based on the combination of these dual negative consumption behaviors. Results show that there is a compensatory role of physical activity for these direct positive effects of fast food and sugar-sweetened drink consumption, as indicated by the negative relationship between activity and overweight / obese status. That is, the direct effect of the calories associated with fast food consumption on overweight / obesity likelihood is at least partially offset by a high level of physical activity. However, physical activity did not appear to offset the direct effect of sugar-sweetened beverage consumption on overweight / obesity likelihood. In addition, the conditional mediation analyses suggest that there are limits for the compensatory role of physical activity. When young consumers drink sugar-sweetened beverages consumption (1 standard deviation above the mean sugar-sweetened beverage consumption level), the compensatory intervening role of physical activity is nonsignificant. This

suggests that there is a dual threat posed by the combination of high levels of fast food and sugar-sweetened beverage consumption.

This pattern of findings related to childhood overweight / obesity status that combine the direct and moderating roles of fast food and sugar-sweetened beverage consumption, along with the counterbalancing role of physical activity, extend our current understanding of these potential drivers of childhood obesity and offer some potential implications for health policy. It seems clear that reduction in both fast food and sugar-sweetened drinks can have some favorable effects and that increases in physical activity may have a positive impact. Yet, there is little research examining the more complex pattern of relationships observed in our model. There was a stronger effect of fast food consumption when sugar-sweetened beverages were consumed less frequently, suggesting the potential for the negative effect of fast food consumption even when sugar-sweetened beverage consumption is kept at a minimal level. The intervening role of physical activity that helps to partially mitigate the direct effect of fast food consumption is consistent with the energy expenditure input-output framework (Hall et al, 2012). However, sixty minutes of physical activity daily is now outside of the level achieved by many children. Even with high levels of physical activity, the conditional mediation suggests that the activity is not sufficient to intervene and counter the higher levels of calories consumed from *both* sweetened beverages and fast food consumption. Thus, health and policy advocates that suggest more physical activity to neutralize negative consumption activities should recognize its limits.

Children encountering the "double trouble" associated with calorie-laden fast food and sugar-sweetened beverage consumption are prime targets for childhood obesity problems. In contrast, those engaging in a single problematic consumption behavior appear to be able to more effectively rely upon a high level of physical activity to help defuse the impact on overweight / obesity likelihood. However, while not emphasized in our predictions, there was a negative relationship between fast food consumption and level of physical activity. This suggests that there is a segment of children who most need the physical exercise that is least likely to be receiving it. Beyond the double trouble associated with the two negative consumption behaviors, the positive direct effects of fast food and sugary beverage consumption alongside the direct effect of physical inactivity on overweight / obesity likelihood suggests a concern with the combination of high fast food and sugar laden beverage consumption occurring concurrently with low levels of physical activity. This clearly represents the primary target for interventions designed to reduce childhood obesity.

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