11-1-2016

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## Repository Citation

Feng, D., Song, H., Esperat, M. C., Black, I. (2016). A Multicomponent Intervention Helped Reducing Sugar-Sweetened Beverage Intake in Economically Disadvantaged Hispanic Children. *American Journal of Health Promotion, 30*(8), 594-603.
http://dx.doi.org/10.4278/ajhp.140801-QUAN-384

*Nutrition; Youth; Underserved Population*

# A Multicomponent Intervention Helped Reduce Sugar-Sweetened Beverage Intake in Economically Disadvantaged Hispanic Children

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***Abstract***

***Purpose.*** *This study aimed to examine the effect of a multicomponent intervention program on consumption of sugar-sweetened beverages (SSBs), and lifestyle factors associated with SSB intake, in Hispanic children from low-income families.*

***Design.*** *A five-wave longitudinal study using a quasi-experimental design was conducted.*

***Setting.*** *Five elementary schools in West Texas served as the setting.*

***Subjects.*** *Participants included 555 predominantly Hispanic children (ages 5–9 years) from low-income families and their parents ($n = 525$).*

***Intervention.*** *A multicomponent intervention program was implemented.*

***Measures.*** *Children's anthropometric measures were obtained. Their weight status was determined based on body mass index for age and gender. Parents responded to a demographic questionnaire, a shelf inventory, an acculturation scale, and a family survey.*

***Analysis.*** *Growth curve analyses were used to test differences between intervention and comparison participants' SSB intake and to examine potential covariates.*

***Results.*** *Comparison group children's daily SSB intake significantly increased over time ($B = 1.06 \pm .40$ ounces per month, $p < .01$), but this linear increase of SSB was slowed down by the intervention ($B = -.29 \pm .12$, $p < .05$). More daily TV time, more fast food intake, and more types of SSBs available at home were associated with higher SSB intake.*

***Conclusion.*** *Risk factors of childhood obesity were associated with each other. The intervention program produced a modest reduction in SSB consumed by economically disadvantaged and predominantly Hispanic children.*

***Key Words:*** Childhood Obesity, Sugar-Sweetened Beverages, Hispanic, Growth Curve Analysis, Body Mass Index (BMI), Prevention Research. Manuscript format: research; Research purpose: intervention testing/program evaluation and modeling/relationship testing; Study design: quasi-experimental; Outcome measure: behavioral, anthropometric, and survey; Setting: family and school; Health focus: nutrition, weight control, and physical activity; Strategy: education and behavior change; Target population age: youth; Target population circumstances (specify all that apply): low-income, west Texas, and Hispanic

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*This manuscript was submitted August 1, 2014; revisions were requested December 15 2014 and March 2, 2015; the manuscript was accepted for publication March 20, 2015.*


*0890-1171/00/$5.00 + 0*
*DOI: 10.4278/ajhp.140801-QUAN-384*

## PURPOSE

Childhood obesity/overweight prevalence has received much attention in the past two decades. National data show that 34.2% of children ages 6 to 11 years and 34.5% of children ages 12 to 19 years are overweight or obese (i.e., body mass index [BMI] ≥85th percentile).[1] The overweight/obesity prevalence is 29.8% among Hispanic-American ages children 2 to 5 years and 46.2% among those ages 6 to 11 years. Hispanic-American boys are particularly at high risk of becoming overweight/obese, with an alarming prevalence of 48.7% among 6- to 11-year-olds, compared with 26.5% among non-Hispanic white boys of the same age.[1]

Consumption of sugar-sweetened beverages (SSB), such as carbonated soft drinks, fruit drinks, sports/energy drinks, sweetened tea, and lemonade, contributes to childhood obesity.[2] Paralleling the obesity prevalence, SSB consumption increased in all age groups during the past two decades, with the low-income group being one of the most vulnerable SSB overconsumers.[3] Caloric sweetener consumption increased worldwide by 74 kcal/d between 1962 and 2000, and SSB contributed 80% to this increase.[4] Urbanization and income growth may have contributed to this dietary change.[5]

### Sweetened Beverage Intake and Health Outcomes

Sugar-sweetened soft drinks are a prevalent source of readily absorbable sugars. Epidemiologic evidence has linked greater SSB consumption with higher risks of obesity, type 2 diabetes,

hypertension, and metabolic syndrome in children and adults.[2,6–9] Higher SSB consumption by children (ages 3–11 years) was associated with increased C-reactive protein levels, increased waist circumference, and decreased high density lipoprotein cholesterol levels.[10] The risk of cardiovascular disease mortality rises greatly with an increased intake of calories from added sugar in SSBs.[11] A longitudinal study found that greater SSB consumption in childhood and adolescence predicted a weight gain trajectory well into adulthood.[12] A meta-analysis concluded that there are clear associations of soft drink intake with increased energy intake and body weight, lower intake of milk, calcium, and other nutrients, and an increased risk of several medical problems (e.g., diabetes).[13] Thus, a decrease in consumption of SSBs would assist in preventing weight gain because these drinks are a major source of calories.[14]

Research found that longer hours of TV viewing and higher levels of sweetened beverage consumption were important factors in overweight prevalence in Hispanic-American children.[15] Additionally, predisposition to obesity may be associated with differential beverage consumption patterns, with high-risk children consuming more caloric beverages than low-risk children.[16]A longitudinal study found an association between increased soda intake during 3 years and an increase in waist circumference, but a negative relationship between milk intake and change in waist circumference.[16] A study of preschool children concluded that increased SSB intake between meals more than doubled the risk of overweight among some young children, controlling for other important covariates.[17] Even infrequent drinking of SSBs (e.g., once or twice daily) may increase the odds of becoming/remaining overweight.[18] More recently, fruit juice received attention as a potential source of high-energy beverages that may contribute to childhood obesity.[19]

Older children, those of lower socioeconomic status, and children who consume more salt are more likely to consume SSBs.[20] Overweight or glucose-intolerant children are more likely to experience adverse metabolic effects of SSB consumption compared with normal-weight children or children without glucose intolerance.[21] Early intake of sweetened beverages predicts adiposity and weight status across childhood and adolescence: SSB intake at age 5 years was positively associated with body fat percentage, waist circumference, and weight status from ages 5 to 15 years.[22] Adolescents' sports drink consumption was related to higher video game use, SSB and fruit juice intake, and smoking.[23] Other negative health consequences of SSB intake among children include increased risks of dental decays,[24] bone fractures,[25] and poor overall nutrition.[26]

***Mechanism of How Sweetened Beverage Intake May Affect Weight Status.*** The mechanism through which SSB intake may lead to weight gain/obesity in children is inconclusive. A study based on 1999–2002 NHANES data reported that increased beverage consumption was associated with an increase in the total energy intake by preschool children, but not with their BMI,[27] whereas some research found that total energy intake mediates the relationship between consumption of SSB and BMI gains. For example, a prospective study of more than 10,000 children ages 9 to 14 years concluded that adjustment for total caloric intake greatly attenuated the estimated associations between SSB consumption and change in BMI in the following year, indicating that SSB may contribute to increased BMI by adding to the total caloric intake.[28] One possible explanation is that caloric compensation is less complete for liquid food rather than solid food; thus, low-viscosity foods are associated with greater caloric intake and weight gain.[9] Another possibility is that consumption of high-fructose corn syrup, the main caloric sweetener for beverages in the United States, may contribute to higher energy intake and weight gain by suppressing insulin secretion and enhancing leptin production, which are important hormones for energy balance regulation.[9] The cost of SSB is less explored, although obesity is associated with limited economic resources.[29] Capacity for consuming SSBs may be more linked to their low price than the sugar content.[29] Research has associated low-cost SSB with weight gain/obesity.[6]

**Effects of School-Based Interventions on Reducing Sweetened Beverage Intake**

Although more research is needed, available scientific evidence supports recommendations to reduce SSB consumption as a strategy for weight management and constructing a healthy lifestyle, especially among children and adolescents. Nutrition guidelines and financial benefits from vending machines affect SSB access at schools.[30] As an attractive channel for obesity prevention and intervention,[31] school-based intervention programs should encourage young children to minimize their SSB intake, or replace SSB with calorie-free drinks, such as water or diet soft drinks.[9]

A few school-based intervention programs reported effectiveness in reducing children's SSB intake. A cluster randomized control trial reported a modest reduction in consumption of carbonated drinks, which was associated with a reduced number of overweight/obese children.[24] A student-designed-and-led intervention implemented in Appalachian schools reported a significant decrease in daily SSB servings and increased water consumption in adolescents.[32] Another randomized control trial of adolescents who regularly consumed SSB found that home deliveries of noncaloric beverages almost completely eliminated SSB consumption in a diverse group of adolescents, which benefited adolescents with heavier baseline body weight the most.[33] Gender and ethnicity are also important factors to consider in evaluating interventions for decreasing SSB intake. For example, a program targeting middle school students reported high participation rate, but only girls showed significant behavioral changes.[34] A school-based intervention focusing on kindergarten through first-grade American Indian children reported a significant reduction in parental reports of child intakes of SSB, whole milk, and chocolate milk.[35] However, evaluation research using young Hispanic children is scarce, and controversies exist in the literature.

**Purpose of the Current Study**

The current paper was to evaluate the effect of a multisite and multi-

component (including nutrition education, exercise, gardening, and home visits) intervention program on young Hispanic children's SSB consumption, and to examine the association between children's SSB consumption and anthropometric outcomes. Specifically, we hypothesized that:

- Hypothesis 1: Participation in the multicomponent intervention program is related to a significant decrease in children's SSB intake.
- Hypothesis 2: The trajectory of children's SSB consumption is associated with their BMI percentile for age and gender, body fat percentage, and waist circumference.

Table 1
Demographic Characteristics of the Current Study Sample*

| | Children (n = 555) | Parents (n = 525) |
|---|---|---|
| Age at baseline, y | | |
| Range | 5–9 | 18–81 |
| Mean (SD) | 6.68 (0.96) | 33.02 (8.01) |
| Sex, female, % | 53 | 87 |
| Grade at school, % | | |
| Kindergartener at wave I | 22 | — |
| First grader at wave I | 38 | — |
| Second grader at wave I | 28 | — |
| New kindergartener at wave III | 12 | |
| Education, % | | |
| Some elementary | — | 2 |
| Elementary | — | 7 |
| Some junior high | — | 6 |
| Junior high | — | 11 |
| Some high school | — | 17 |
| High school grad/GED | — | 28 |
| Some college | — | 22 |
| Bachelor's degree | — | 6 |
| Graduate degree | — | 2 |
| Annual household income at baseline, % | | |
| $0–$15,000 | — | 41 |
| $15,001–$30,000 | — | 39 |
| $30,001–$45,000 | — | 8 |
| $45.001–$60,000 | — | 5 |
| $60.001–$75,000 | — | 1 |
| Over $75,000 | — | 6 |
| Participated in at least one food/nutrition assistance program, % | | 73 |

* A total of 525 parents and 555 children formed 566 distinct parent-child dyads, which are nested in 513 families. Dash indicates data not applicable.

## METHODS

### Design

A longitudinal study with a quasi-experimental design was used. The intervention and comparison groups were matched on school-level demographic characteristics. The interventions lasted about 18 months. Data collection was conducted at five schools at baseline and approximately 4, 10, 16, and 22 months after baseline.

### Sample

We collected data from kindergarten through second-grade students in two independent school districts in west Texas: Lubbock and San Elizario. In Lubbock, students from one intervention school (n = 115) and one comparison school (n = 104) provided baseline data. In San Elizario, all kindergarteners went to one primary school, which had 17 classes. We randomly selected nine of these classes as intervention classes, the other classes as comparison, and provided training for school teachers and administrators to minimize sample contamination. In San Elizario, 41 intervention kindergarteners and 28 comparison kindergarteners provided baseline data, along with first- and second-grade students from one intervention elementary school (n = 176) and one comparison school (n = 133). Overall, 332 students with 278 parents from the intervention schools/classes and 265 students with 187 parents from the comparison schools/classes provided anthropometric and survey data at baseline, respectively.

This study was approved by the Internal Review Board of Texas Tech University Health Sciences Center. Informed consent was obtained from all participating parents/legal guardians, and assent from children. More than 70% of all eligible students participated, and about 70% of parents/legal guardians of the participating children completed self-report surveys at baseline. Most parent respondents were female (87%), Hispanic (88%), and had no college education (70%); most families had below $30,000 annual income (80%) and participated in at least one food/nutrition assistance program (73%). About 53% of participating children were girls; approximately 32% of participating children were overweight or obese (BMI for age and gender $\geq$85th percentile). See Table 1 for detailed sample characteristics.

After baseline, some students dropped out because of transfer, whereas new participants who gave consent were added. Parents might not have returned the survey in all waves, and might not have answered all survey questions at each wave. Thus, available data for hypothesis testing differed across waves and varied depending on which variables were involved in the specific analysis. All intervention students were exposed to the intervention at the same time.

The current analytic sample is a subset of the larger study, including 566 parent/guardian-child dyads (525 distinct parents/guardians and 555 distinct children) nested in 513 families (292 from the intervention and 221 from the comparison groups), where the parent self-reported to be Hispanic. These dyads provided 1258 observations across five waves. The impact of missing data in this study was mini-

mized through the full information maximum likelihood estimation method, which uses all available observations in parameter estimation and hypothesis testing.[36–38]

### Measures

The following measurements were obtained at each wave:

***Demographic Characteristics and Acculturation.*** Demographic data (e.g., age, gender, race, occupation status, marital status, and highest achieved educational degree) were collected at baseline from parents/guardians. Because children younger than 9 years cannot accurately report food intake or physical activity, parents provided information on all family survey items. We used the Brief Acculturation Rating Scale for Mexican Americans–II, which has been shown to have adequate reliability and validity, to measure parents' acculturation level.[39] A scale score was computed based on 12 items measuring language, ethnic identity, and ethnic interaction, using a 5-point Likert scale. A higher acculturation scale score indicates that the respondent is more Anglo oriented.

***Anthropometric Measures.*** Standardized anthropometric measurements were performed at each wave. Students' height was measured to the nearest 0.1 cm using a stadiometer, and weight was measured to 0.1-kg accuracy by a Tanita body composition analyzer (v. TBF 300A, Tokyo, Japan), without shoes or jackets. BMI was calculated based on height and weight,[40] and BMI percentile for age and gender was obtained using the standardized online calculator.[41]

***Sweetened Beverage Intake.*** One of the family survey items asked, "How many ounces of sweetened beverages does your child drink in a typical weekday," and similarly for "a typical weekend day." Parents reported number of ounces separately for soda, fruit drink, sports drink, sweetened tea, and lemonade, based on which an average daily SSB intake was calculated.

***Home Availability of Sweetened Beverage.*** Food availability was measured using a shelf inventory that has documented reliability and validity when used with a variety of audiences, including Hispanics.[42] To assess the readability and cultural appropriateness of this survey, personal interviews with mothers (n = 37) in low-income Hispanic communities were conducted in a pilot study.[43] Respondents checked off whether various foods listed were available in the refrigerator, freezer, or pantry shelves in the home (1 = present; 0 = not present). Answers were summed up to create subscale scores indicating the number of food items mentioned in each of 12 food categories. Home availability of SSB was indicated by the score of the sweetened beverage category.

***Family Meals and Fast Food.*** One family survey item asked, "In a typical week, how many times does your family eat a meal together?" Another item asked about the study child's intake of fast food: "In a typical week, how many times does your child eat food from a fast food restaurant like McDonald's, Sonic, Kentucky Fried Chicken, Taco Bell, etc." Responses to these questions were rated on a 5-point Likert scale (0 = never; 4 = every day).

***Daily TV Time.*** Parents/guardians' report of the child's time spent on viewing TV and DVDs on a typical weekday/weekend day was obtained, based on which an average daily TV time was computed in hours. Daily computer usage was reported in the same manner; however, the current study used daily TV time as a covariate, because a preliminary analysis (results not shown) revealed that SSB intake is more strongly related to TV viewing.

### Intervention

***School-Based Activities.*** The multicomponent *Transformacion Para Salud* program, aiming to prevent and control childhood obesity among predominantly Hispanic young children ages 5 to 9 years, was implemented from January 2007 to November 2008. This program used a community-based participatory research approach. The two sites were chosen for variation in population, urbanization, and acculturation of the Hispanic population. A bilingual school-based curriculum emphasizing knowledge and skills for healthy eating, the *Bienestar* Health Program,[44] was adapted. It contained 10 weekly hour-long lessons per grade level, along with take-home workbooks, which were taught as part of science or other classes. In addition, teachers at the intervention schools were trained to integrate an adapted Junior Master Gardeners[45] curriculum in science classes. Trained instructors and classroom teachers taught these lessons at the intervention schools during the first and second years of the project, respectively. For exercise intervention, physical education teachers at the intervention schools were trained to implement a martial arts curriculum designed for the current project. Children received take-home workbooks and brought information sheets to their parents. Monthly newsletters were sent to intervention parents, and Family Fun Nights were implemented at intervention schools biannually to increase family involvement and parental awareness. Parents/guardians of all kindergarten through second-grade students who were enrolled at the intervention schools were exposed to the multicomponent intervention program, along with their children, whether they participated in the evaluation research or not. We did not evaluate findings from the workbooks/newsletters separately from the impact of the overall program; however, perception and usage of these materials were positive among parents who attended Family Fun Nights.

***Home Visitation.*** More than 30% of the intervention students (n = 145) had BMI for age and gender ≥85th percentile at baseline, and their parents/guardians were invited to participate in a home visitation program. Certified community health workers provided monthly home visits to 56 families (approximately 40% of eligible families) throughout the intervention period. More than 100 parents were enrolled initially, but some parents dropped out or missed confirmation appointments, mainly because of their busy schedule and competing family and work responsibilities. Using an eight-section bilingual protocol created for this program, community health workers taught parents topics on building family strength, nutrition, and physical activity, based on current best practices.[46] The first visit was focused

on rapport building, and the second visit was based on identifying areas needing improvement (e.g., decreasing SSB intake, reducing screen time) and individual goal setting. Subsequent lessons were self-paced and individualized for each family. Depending on their unique situation and needs, parents were encouraged to provide children with ample access to nutrient-dense foods and beverages and high-fiber foods, avoid excessive restriction of nutrient-poor foods; avoid the use of food as a reward; increase fun and feasible physical activity to balance energy intake; reduce TV and video game time; and eat meals and exercise together. Community health workers helped participants assess their goal achievement, adjust goals, and set new goals.

**Analysis**

We obtained descriptive statistics of all study variables, checked distributions of continuous variables for nonnormality and outliers, and conducted multicollinearity test and Levene test for equality of variances when appropriate. Bivariate correlations (*r*) between children's SSB intake and their anthropometric measures (i.e., BMI percentile, body fat %, and waist circumference) were obtained within each wave. These preliminary analyses were conducted using SPSS 21.0 (Chicago, Illinois).

We used the SAS (Cary, North Carolina) PROC MIXED procedure to conduct a multilevel latent growth curve analysis (LGCA) for main hypothesis testing. Advantages of LGCA over the traditional multivariate analysis of variance/analysis of covariance (MANOVA/ANCOVA) models are well documented.[47–50] For example, LGCA can properly assess within-individual change over time by allowing for different intercepts (initial status) and slopes (rate of change) for different individuals, test predictors of interindividual variability in change by including time-invariant and time-varying covariates, and easily handle unequal time intervals across waves (such as the temporal design of the current study). Also, because maximum likelihood estimation of growth parameters is obtained using all available observations from all individuals, missing data are less of a problem with LGCA, compared with the traditional ANCOVA approach.

The goals of the multilevel longitudinal analyses are to investigate (1) the level 1 within-subject change (the time effect) on daily SSB intake, (2) the effects of level 2 between-subject covariates (i.e., group membership, parents' education and acculturation, family income, family meals, child gender and age at baseline, child fast food intake and daily TV time, and home availability of SSBs) on the growth parameters, and (3) whether the time effect varies across the study groups. Maximum likelihood estimations based on all available observations (which were clustered by families) were used to estimate level 1 and level 2 fixed effects. To test the level 1 time effect, both linear and quadratic effects of time (measured in months and centered around the grand mean of 10.4 months to reduce multicollinearity) were estimated. Because the quadratic growth model fits the data better with smaller absolute Akaike information criterion and Bayesian information criterion scores than the linear model, it was selected for the model with level 2 covariates. Intervention was coded as 1 = intervention, and 0 = comparison. A dichotomous variable, P_Edu, indicated whether the parent had at least a high school diploma: 1 = high school or above; 0 = no high school diploma. The LGCA of children's daily sweetened beverage intake is shown in Equation 1:

$$\begin{aligned} Y_{ij} = \beta_{00} &+ \beta_{01} \times Intervention \\ &+ \beta_{02} \times Pedu \\ &+ \beta_{03} \times Acculturation \\ &+ \beta_{04} \times gender + \beta_{05} \times Age_{baseline} \\ &+ \beta_{06} \times FamilyIncome \\ &+ \beta_{07} \times DailyTV \\ &+ \beta_{08} \times FastFood \\ &+ \beta_{09} \times FamilyMeal \\ &+ \beta_{010} \times TypesSSB \\ &+ \beta_{10} \times Month_{gc} \\ &+ \beta_{11} \times Month_{gc} \times Intervention \\ &+ \beta_{12} \times Month_{gc} \times Age_{baseline} + \delta_{0j} \\ &+ \delta_{1j} + \varepsilon_{ij} \end{aligned} \tag{1}$$

The LGCA of children's anthropometric outcomes was conducted in a similar manner. We tested whether the trajectory of a child's SSB intake is associated with that of his or her BMI percentile, body fat percentage, and waist circumference, respectively. Time-invariant level 2 covariates included group membership, child gender and age at baseline, and parents' education and acculturation; the time-varying covariate is child daily SSB intake. The LGCA of children's anthropometric outcomes is based on Equation 2:

$$\begin{aligned} Y_{ij} = \beta_{00} &+ \beta_{01} \times Intervention \\ &+ \beta_{02} \times Pedu + \beta_{04} \times gender \\ &+ \beta_{05} \times Age_{baseline} \\ &+ \beta_{06} \times Age_{baseline} \times Intervention \\ &+ \beta_{07} \times DailySSB \\ &+ \beta_{10} \times Month_{gc} \\ &+ \beta_{11} \times Month_{gc} \times Intervention \\ &+ \beta_{12} \times Month_{gc} \times Age_{baseline} + \delta_{0j} \\ &+ \delta_{1j} + \varepsilon_{ij} \end{aligned} \tag{2}$$

## RESULTS

**Descriptive and Preliminary Analyses**

Table 1 shows demographic characteristics of the study sample. Table 2 shows mean (SD) of the analytic variables by time and by study group. SSB intake by the intervention group (mean, 22.50; SD, 17.16) at wave V was significantly lower ($p < .05$) than that by the comparison group (mean, 27.11; SD, 20.57); no other significant group mean differences were found for the study variables. Bivariate *r* values presented in Table 3 show that children's SSB intake was not significantly correlated with their anthropometric outcomes measured concurrently.

Prior to LGCA, we computed a change score of children's SSB intake by subtracting their baseline intake from SSB intake at the last available data collection for each subject (e.g., if a child's wave V SSB intake was missing, his or her wave IV intake was used), and tested the significance of group differences in the change score using an ANCOVA. The ANCOVA followed by Tukey least significant difference post hoc tests showed that (1) the intervention group had a smaller increase in SSB intake than the comparison group, after controlling for parents' acculturation, $F(1,477) = 10.18$, $p < .01$, and (2) the mean difference was significant between SSB intake by kindergarten

**Table 2**
**Mean ± SD of Children's Daily Sweetened Beverage Intake and Anthropometric Measures by Study Groups†**

| | Intervention Group | | | |
|---|---|---|---|---|
| | SSB Intake, oz, Mean ± SD (n) | BMI Percentile, Mean ± SD (n) | Body Fat %, Mean ± SD (n) | Waist, cm, Mean ± SD (n) |
| Baseline | 20.59 ± 16.58 (164) | 66.51 ± 28.51 (164) | 22.82 ± 9.62 (163) | 59.81 ± 9.29 (164) |
| Wave II | 20.07 ± 17.03 (104) | 62.64 ± 27.81 (103) | 19.70 ± 7.63 (104) | 59.74 ± 8.19 (104) |
| Wave III | 16.22 ± 14.17 (186) | 64.73 ± 29.17 (190) | 20.98 ± 9.21 (190) | 60.19 ± 10.00 (189) |
| Wave IV | 17.23 ± 12.91 (109) | 64.17 ± 28.49 (110) | 20.95 ± 8.03 (110) | 60.66 ± 10.08 (110) |
| Wave V | 22.50 ± 17.16 (179)* | 63.44 ± 30.88 (179) | 22.41 ± 9.43 (179) | 64.12 ± 11.48 (176) |

† SSB indicates sugar-sweetened beverage; BMI, body mass index; Wave II ≈ 4 months after baseline; Wave III ≈ 10 months after baseline; Wave IV ≈ 16 months after baseline; and Wave V ≈ 22 months after baseline.
* The intervention group mean is significantly lower than the comparison group mean at $\alpha = 0.05$ level.

(mean, 8.91; SD, 1.95) and first grade (mean, 2.83; SD, 1.51) children, $t(482) = 6.09$, $p < .01$, as well as between kindergarten (mean, 8.91; SD, 1.95) and second grade (mean, 2.39; SD, 1.73) children, $t(482) = 6.52$, $p < .01$.

**Multilevel Growth Curve Modeling**

Potential covariates of children's SSB intake were examined through two-level LGCA (Table 4). Linear increase of children's daily SSB intake was significant for the comparison group ($B = 1.06 \pm .40$ rate per month, $p < .01$), but this linear increase of SSB was slowed down by the intervention, as indicated by the significant interaction between intervention and month ($B = -.29 \pm .12$, $p < .05$). Table 4 also shows that family income, parents' education level, and parents' acculturation did not affect their children's daily SSB intake. Among the time-varying covariates, more daily TV time, more fast food intake, and more types of SSBs available at home were associated with higher daily SSB intake of the target child participant ($\beta_{07} = .91 \pm .21$, $p < .01$; $\beta_{08} = 2.19 \pm .58$, $p < .01$; $\beta_{10} = 1.19 \pm .23$, $p < .01$, respectively), whereas having family meals every day was associated with less SSB intake ($\beta_{09} = -1.34 \pm .61$, $p < .05$).

The effect of daily SSB intake on children's anthropometric outcomes was tested using a similar two-level LGCA, controlling for parents' education, acculturation, and family income, and the child's age at baseline and gender. As seen in Table 5, children's anthropometric outcomes were not significantly affected by daily SSB intake, nor were they significantly affected by family income, parents' education level, or parents' acculturation. Results shown in Table 5 did not reveal any significant linear increase in comparison group children's BMI percentile ($B = -.26 \pm .35$ rate per month, not significant) or waist circumference ($B = .01 \pm .11$ rate per month, not significant), but did show a significant linear increase in their body fat percentage ($B = .31 \pm .12$ rate per month, $p < .01$).

No significant interaction between intervention and month was found, indicating that the intervention did not have an effect on the linear rate of change of these measures. The significant effects of the child's gender and age at baseline show that males and older children had significantly higher BMI percentile, higher body fat %, and larger waist circumference, compared with females and younger children. The significant interaction effect between child's age at baseline and month on waist circumference indicates that the older the child was at baseline, the faster the increase of waist circumference ($B = .04 \pm .02$ rate per month, $p < .01$). No other significant effects were found for the parents' variables included in these LGCAs.

## DISCUSSION

Hypothesis 1, regarding the effectiveness of the intervention on children's SSB intake, was supported by significant fixed effects of study group member-

**Table 3**
**Pearson Correlation (*r*) Between Children's Daily Sweetened Beverage Intake and Anthropometric Measures Within Each Wave†**

| | SSB and BMI Percentile, *r* (n) | SSB and Body Fat %, *r* (n) | SSB and Waist Circumference, *r* (n) |
|---|---|---|---|
| Baseline | 0.05 (228) | 0.11 (227) | 0.11 (228) |
| Wave II | 0.01 (188) | −0.01 (192) | 0.06 (192) |
| Wave III | 0.04 (315) | 0.08 (315) | 0.07 (314) |
| Wave IV | 0.00 (203) | 0.00 (203) | 0.00 (203) |
| Wave V | −0.02 (313) | 0.05 (313) | 0.04 (313) |

† SSB indicates sugar-sweetened beverage; BMI, body mass index; Wave II ≈ 4 months after baseline; Wave III ≈ 10 months after baseline; Wave IV ≈ 16 months after baseline; and Wave V ≈ 22 months after baseline.

**Table 2, Extended**

| Comparison Group | | | |
|---|---|---|---|
| SSB Intake, oz, Mean ± SD (n) | BMI Percentile, Mean ± SD (n) | Body Fat %, Mean ± SD (n) | Waist, cm, Mean ± SD (n) |
| 18.40 ± 14.44 (70) | 63.03 ± 31.41 (71) | 21.60 ± 9.26 (71) | 58.87 ± 9.56 (71) |
| 19.21 ± 14.69 (90) | 62.99 ± 31.51 (88) | 21.13 ± 10.11 (91) | 61.74 ± 10.44 (91) |
| 19.36 ± 15.13 (132) | 59.47 ± 32.80 (138) | 21.45 ± 10.08 (138) | 66.67 ± 11.32 (138) |
| 20.05 ± 13.41 (95) | 56.70 ± 33.82 (96) | 19.64 ± 9.67 (96) | 60.66 ± 10.56 (96) |
| 27.11 ± 20.57 (134) | 62.93 ± 33.29 (135) | 22.35 ± 10.23 (135) | 65.38 ± 12.80 (134) |

ship, based on LGCA results: children's SSB intake tends to increase while they grow from kindergarten to the second grade, but intervention children had a smaller increase compared with comparison children. This finding is consistent with the literature, which indicated that school-based intervention programs targeted at reducing SSB intake in children can have a positive influence on decreasing the amount of SSB children consume.[24,32,33]

On the other hand, hypothesis 2, regarding the association between children's SSB consumption and anthropometric measures, was not supported, contradicting some literature that showed that SSB consumption has a positive association with an increased risk for obesity[2,6] and increased waist circumference.[7] Meta-analyses of prospective cohort studies and randomized control trials showed an association between reductions of children's SSB intake and reduction of their BMI gain; however, the effect size of reducing SSB intake on weight gain and body fat is small.[51,52] For instance, a study found that total elimination of SSB from children's diet yielded significant but slight changes in BMI and body fat outcomes.[53] The lack of statistically significant associations between anthropometric measures of adiposity/obesity and the intake of SSBs in the current study is not entirely surprising, considering the small effect size found in the literature, and the fact that we did not eliminate children's SSB intake in our study (e.g., the intervention group had approximately 20 ounces of daily SSB intake at wave V, compared with about 27 ounces of that of the comparison group).

The significant interaction effect of grade level (using kindergarten as the reference) by group membership indicates that the intervention is more effective for first- and second-graders (i.e., older children in the current study, who normally drink more SSB without the intervention and who are more cognitively mature). These results are consistent with the literature,

**Table 4**
**Unstandardized Maximum Likelihood Estimates for Two-Level Random Coefficient Growth Curve Model Predicting Children's Daily Sweetened Beverage Intake†**

| | Parameter | Unstandardized Coefficient |
|---|---|---|
| Fixed effects | | |
| Time-invariant covariates | | |
| Intercept | $\beta_{00}$ | 4.53 ± 4.60 |
| Intervention | $\beta_{01}$ | −0.33 ± 1.13 |
| Parent education | $\beta_{02}$ | −0.74 ± 1.25 |
| Acculturation | $\beta_{03}$ | 0.33 ± 0.30 |
| Child gender | | |
| Male | $\beta_{04}$ | −0.04 ± 1.04 |
| Female | | 0 |
| Child age at baseline | $\beta_{05}$ | 1.54 ± 0.48* |
| Time-varying covariates | | |
| Month (centered) | $B_{10}$ | 1.06 ± 0.40* |
| Month (centered) × intervention | $B_{11}$ | −0.29 ± 0.12** |
| Month (centered) × child baseline age | $B_{12}$ | −0.10 ± 0.05 |
| Family income | $\beta_{06}$ | −0.15 ± 0.44 |
| Daily TV time | $\beta_{07}$ | 0.91 ± 0.21*** |
| Fast food | $\beta_{08}$ | 2.19 ± 0.58*** |
| Family meal | $\beta_{09}$ | −1.34 ± 0.61** |
| Types of SSB available at home | $\beta_{010}$ | 1.19 ± 0.23*** |
| Variance components | | |
| Level 1 | | |
| Within-person | $\sigma^2_\varepsilon$ | 85.18 ± 9.82*** |
| Level 2 | | |
| In initial status | $\sigma^2_0$ | 0.47 ± 0.64 |
| In rate of linear change | $\sigma^2_1$ | 0.53 ± 0.11*** |

† SSB indicates sugar-sweetened beverage.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

**Table 5**
**Unstandardized Maximum Likelihood Estimates for Two-Level Random Coefficient Growth Curve Models Predicting Child BMI Percentile, Body Fat Percentage, and Waist Circumference†**

| | Parameter | BMI Percentile, *B* | Body Fat %, *B* | Waist, cm, *B* |
|---|---|---|---|---|
| Fixed effects | | | | |
| Time-invariant covariates | | | | |
| Intercept | $\beta_{00}$ | 36.23 ± 5.98* | 4.68 ± 1.87** | 29.86 ± 1.92* |
| Intervention | $\beta_{01}$ | 2.52 ± 2.66 | 0.67 ± 0.82 | 0.92 ± 0.87 |
| Parent education | $\beta_{02}$ | 4.87 ± 2.61 | 1.50 ± 0.82 | 2.16 ± 0.83 |
| Acculturation | $\beta_{03}$ | −0.62 ± 0.67 | −0.15 ± 0.21 | 0.11 ± 0.21 |
| Child gender | | | | |
| Male | $\beta_{04}$ | 5.00 ± 1.87** | 1.80 ± 0.58* | 1.82 ± 0.60*** |
| Female | | 0 | 0 | 0 |
| Child age at baseline | $\beta_{05}$ | 3.05 ± 0.70* | 2.13 ± 0.22* | 4.20 ± 0.22* |
| Time-varying covariates | | | | |
| Month (centered) | $B_{10}$ | −0.26 ± 0.35 | 0.31 ± 0.12*** | 0.01 ± 0.11 |
| Month (centered) × intervention | $B_{11}$ | −0.08 ± 0.10 | −0.00 ± 0.03 | −0.02 ± 0.03 |
| Child age at baseline × month | $B_{12}$ | 0.04 ± 0.05 | −0.03 ± 0.02 | 0.04 ± 0.02*** |
| Family income | $\beta_{06}$ | −0.24 ± 0.63 | −0.13 ± 0.20 | −0.14 ± 0.20 |
| Daily SSB intake | $\beta_{07}$ | −0.00 ± 0.03 | 0.01 ± 0.01 | 0.01 ± 0.01 |
| Variance components | | | | |
| Level 1 | | | | |
| Within-person | $\sigma_{\varepsilon}^2$ | 806.89 ± 54.21*** | 76.90 ± 5.19* | 87.02 ± 5.84*** |
| Level 2 | | | | |
| In initial status | $\sigma_0^2$ | 2.03 ± 1.36 | 0.15 ± 0.15 | 0.85 ± 0.15* |
| In rate of linear change | $\sigma_1^2$ | 0.09 ± 0.05** | 0.03 ± 0.01* | 0.01 ± 0.01** |

† BMI indicates body mass index; and SSB indicates sugar-sweetened beverage.
* $p < 0.05$.
** $p < 0.01$.
*** $p < 0.001$.

which indicated that daily SSB intake increases as children grow older.[15] However, our study also showed that the interventions can suppress such an increase in SSB consumption at the early stage. Based on the literature, children who eat fast food, compared with those who do not, consume more SSBs.[54] We found similar results: children who have fast food more frequently tend to drink more SSB ($B = 2.17$, $p < .001$), whereas those who have more family meals drink less SSB ($B = -1.45$, $p < .05$). We also found that children who have more TV time drink more SSB ($B = .87 \pm .21$, $p < .001$), and that having more types of SSBs available at home increased children's intake ($B = .92$, $p < .001$); both of these findings are consistent with the literature.[53,55]

About 61% of the participating parents/guardians were married, 18% were single/never married, and 20% were divorced/separated. We included a parent's marital status and acculturation as time-invariant covariates in the LGCA, but we found no significant moderation effect. These results are in line with prior literature,[16] indicating that Hispanic children from low-income families of different structure and acculturation responded similarly to the program.

The associations between SSB intake and daily TV time, fast food intake, and the number of types of SSBs available at home in a large sample of predominantly low-income Hispanic children have not been reported previously. The fact that these risk factors of childhood obesity tend to coexist suggests that future studies should include related risk factors and examine clusters of risk factors, as well as healthy living characteristics that tend to reinforce each other.

The causes of childhood obesity are multifactorial in nature and often require parental involvement; however, parental involvement has been a challenge to obesity intervention and research, especially in low-income families.[56] We used home visits as another way to get parents involved. Approximately 40% (n = 56) of eligible families participated in the home visitation component of our program. The main barriers to parents' participation were competing family/work responsibilities, which is consistent with the literature.[56]

Because results in published studies are not uniformly reported for various age, gender, and racial/ethnic groups, and different measures are used, comparisons across studies are difficult. In a national sample of Hispanic-American children, 29.8% of 2- to 5-year-olds and 46.2% of 6- to 11-year-olds were above the 85th BMI percentile.[1] In a recent study with Hispanic kindergarten through second-graders in California, 27% were obese, and 46% were above the 85th BMI percentile.[57] The lower prevalence of overweight/obesity found in this study (32%) may have

contributed to the limited number of significant findings.

This study has several limitations. First, a quasi-experimental design was used, which limits the internal validity. Second, with the exception of anthropometric outcomes, all measures were self-reported. A general limitation of the field at this time is that there are no standardized measures of SSB intake, or that of potential covariates such as fast food intake and family meals. For example, some studies used "soft drink" as the only indicator of SSB and missed other SSB contributors (e.g., sweetened tea, fruit-type drinks). Some studies asked how many cans of soft drink respondents consumed,[58,59] not accounting for the intake of soft drinks poured from large containers or fountains, making comparison across studies difficult. Third, the complex longitudinal pattern specific to this study, due to the fact that the participating parent of the target child may drop out because of various reasons, in which case another parent/guardian of the same child was recruited, may affect the test-retest reliability of parents' reports. Fourth, the participation in the home visitation program was relatively low, and everyone was not at the same stage of readiness to change. Analysis of qualitative data collected from parent focus groups (results not shown) indicated that some parents wanted more talks about health education, but other parents might not recognize childhood obesity as a problem and resisted home visits. Finally, the generalizability of our study findings can only extend to kindergarten through second grade students of Hispanic ethnicity.

**SO WHAT? Implications for Health Promotion Practitioners and Researchers**

**What is already known on this topic?**

The obesity epidemic is a public health problem. Consumption of sugar-sweetened beverages (SSBs) contributes to childhood obesity.

**What does this article add?**

As children grow older, their SSB intake increases; however, a targeted, multicomponent education program helped curb this increase among young Hispanic children from low-income families. We also found that more daily TV time, more fast food intake, and more types of SSBs available at home were associated with higher daily SSB intake. The fact that these risk factors of childhood obesity tend to co-occur underlines the importance of multicomponent education and intervention programs.

**What are the implications for health promotion practice or research?**

The battle against childhood obesity needs support from schools and the family. School officials should evaluate their policies on offering SSBs at school and provide alternatives (e.g., free drinking water). Health intervention messages should encourage parents to provide their children with better nutrition choices and support children's physical activity.

**Acknowledgment**

*This project is supported by the National Research Initiative of the U.S. Department of Agriculture Cooperative State Research, Education and Extension Service, grant number 2006-55215-16691.*

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