Influence of School Beverage Environment on the Association of Beverage Consumption With Physical Education Participation Among US Adolescents

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More than 30% of US children are overweight or obese.1,2 Because most children spend more than half their waking time in school, there are 2 widely espoused strategies to fight the obesity epidemic: to eliminate competitive foods and to promote physical activity in school.3,4 An increasing number of states and school districts has established policies requiring students’ regular physical education (PE) participation5,6 to promote physical activity, although observational studies have not found the school physical activity–related environment to influence schoolchildren’s body weight status.7-10 In the meantime, US parents are aware of the availability of unhealthy foods and beverages in children’s sports settings.11 It is unknown whether sports and physical activity prevent childhood obesity, especially in an obesogenic food environment.

Youths’ sports participation has been associated with more consumption of both healthier (e.g., milk and 100% fruit juice) and less healthy (e.g., sugar-sweetened) beverages.12 A 2004–2005 survey in Texas of 11th graders showed that boys who are more active consume sugar-sweetened flavored and sports drinks more frequently than do less active boys. Their physical activity decreased with more frequent soda consumption, but physical activity increased among boys having the highest soda consumption.13 This is likely attributable to the fact that children who are more physically active have greater fluid intake14 because of their increased need to rehydrate. However, to our knowledge, this nonlinear relationship between physical activity and beverage consumption has not been examined in previous research.

Furthermore, availability of beverages in the environment may affect the association of physical activity with beverage consumption, resulting in the nonlinear finding in the Texas survey. More than 50% of US middle school students can buy soft drinks at their schools, regardless of the state-level policies restricting soft drinks on campus.15-17 As US adolescents’ weekly frequency of participation in PE class has been increasing in the past decade,18 how promoting physical activity in schools with available soft drinks influences children’s beverage consumption needs closer examination.

We hypothesized that US adolescents’ physical activity and participation in PE class would be associated with milk and soft drink consumption in a nonlinear fashion. Furthermore, we hypothesized that the associations may be modified by the school food environment (i.e., availability of soft drinks and vending machines). We examined these hypotheses using nationally representative survey data of US eighth-grade adolescents from the Early Childhood Longitudinal Study—Kindergarten (ECLS-K) cohort.

Objectives. We examined the association of adolescents’ beverage consumption with physical activity and studied how their school beverage environment influences the association.

Methods. We used nationally representative data from the 2007 Early Childhood Longitudinal Study—Kindergarten Cohort (n = 8850). We examined nonlinear associations of eighth graders’ self-report of beverage consumption (milk, 100% juices, soft drinks) with moderate to vigorous physical activity and physical education (PE) participation using piecewise linear regression models.

Results. We found a nonlinear association of participation in PE class with beverage consumption, especially in schools with vending machines and those selling soft drinks. For students participating in PE less than 3 days per week, beverage consumption was not significantly associated with participation in PE class frequency. For students participating in PE 3 to 5 days per week, 1 more day of participation in PE class was associated with 0.43 (SE = 0.14; P = .002) more times per week of soft drink consumption and 0.41 (SE = 0.17; P = .021) fewer glasses per week of milk consumption.

Conclusions. The more soft drink and less milk consumption related to high participation in PE class might be prevented by improving the beverage environment in schools. Systematic environmental interventions are needed to prevent such potential unintended consequences of promoting physical activity. (Am J Public Health. 2013;103:e63–e70. doi:10.2105/AJPH.2013.301555)

Methods

The ECLS-K is a nationally representative cohort study from 1998 to 2007. At baseline (1998–1999), kindergarteners were sampled from 1280 schools, using a multistage stratified clustered sampling scheme. Our study was derived from the cross-sectional data of the spring semester of eighth grade (in 2007). Children, their parents, and schoolteachers and administrators provided information about the children’s daily behaviors and family and school environments.19 Final analysis included 8850 adolescents with complete data of beverage consumption (soft drinks, milk, and 100% juice) and physical activity measurements (moderate to vigorous...
physical activity and participation in PE class).

**Variables**

**Beverage consumption.** Adolescents completed a self-administered paper and pencil questionnaire about their food and beverage consumption data (including consumption within and outside school) in the past 7 days before the interview. Questions asked about 3 types of beverages: milk, 100% juices (e.g., orange juice, apple juice, grape juice), and soft drinks (e.g., soda pop, sports drinks, fruit drinks that are not 100% fruit juice). The unit for milk was glass (i.e., a half pint). The unit for the other 2 beverages was frequency.

On the questionnaire, the choices for each beverage included zero, 1 to 3 times or glasses in the last week, 4 to 6 times or glasses in the last week, 1 time or glass per day, 2 times or glasses per day, 3 times or glasses per day, and 4 or more times or glasses per day. We converted the 7 choices into times or glasses per week: 0.0, 1.5, 5.0, 7.0, 14.0, 21.0, or 28.0 times or glasses per week for final analysis. The beverage (except for soft drinks) consumption-related questions on the student self-administered questionnaire were from the Youth Risk Behavior Surveillance System (YRBSS).

**Physical activity.** Adolescents answered 2 questions about their physical activity on the student questionnaire. These 2 questions were the same as those in the YRBSS questionnaire. Regarding MVPA, the question asked, “On how many of the past 7 days did you exercise or participate in physical activity for at least 20 minutes that made you sweat and breathe hard, such as basketball, soccer, running, swimming laps, fast bicycling, fast dancing, or similar aerobic exercise?” The range was 0 to 7 days per week. Regarding PE class participation, the question read, “In an average week when you are in school, on how many days do you go to physical education classes?” The range was 0 to 5 days per week.

**School beverage environment.** School administrators or principals reported school environmental characteristics, including whether the school was public or private and vending machine availability at the school. School location information (i.e., census region and urbanization level) came from the sampling frame of the school. The adolescent participants reported whether students in their school could buy soft drinks on campus.

Adolescents’ characteristics included age (in years), gender, race/ethnicity (White, Black, Hispanic, Asian, other; by parent’s report), adolescents’ self-reported screen time (i.e., time spent TV viewing and playing video games), and total weekly beverage consumption. We converted directly measured body mass index (BMI; defined as weight in kilograms divided by the square of height in meters) into BMI for age percentile, derived from the 2000 Centers for Disease Control and Prevention growth charts for children aged 2 to 19 years: underweight is less than 5th percentile, normal weight is between the 5th and 85th percentiles, overweight is between the 85th and 95th percentiles, and obese is 95th percentile or greater.

We measured adolescents’ self-report of their experience of being accepted in school by a set of questions: This school year, how often did you
1. feel like you fit in at your school,
2. feel close to classmates at your school,
3. feel close to teachers at your school,
4. enjoy being at your school,
5. feel safe at your school.

We coded the 4 choices for each question (never, sometimes, often, always) from 1 (never) to 4 (always). We summed the 5 scores to get an indicator of the adolescent’s perception of fitting in at school (Cronbach’s \( \alpha = 0.71 \)).

Parents reported their family socioeconomic status, including household food security status (using the US Department of Agriculture’s 18-item food security screener, categorized into secure, insecure without hunger, and insecure with hunger), receiving food stamps in the past year, maternal employment status (full time, part time, looking for a job, not in the labor force), and parents’ highest education level (less than high school diploma, high school diploma, bachelor’s degree, postgraduate degree).

**Statistical Analysis**

We performed all statistical analyses considered complex survey design and sampling weight using SAS version 9.2 (SAS Institute, Cary, NC). We estimated mean beverage consumption by individual, family, and school environmental covariates and tested the between-group differences using the analysis of variance F-test. We plotted line charts of mean beverage consumption by frequencies of MVPA and participation in PE class to demonstrate the crude relationships.

To test the relationship between MVPA and beverage consumption, we specified a linear model (model 1). For participation in PE class, we specified a linear model (model 2) and a piecewise linear regression model with a knot at 3 days per week of PE participation to capture the nonlinear relationship (model 3). Finally, we chose a model including both MVPA and participation in PE class: a linear term for MVPA and a piecewise specification for participation in PE class (model 4).

We adjusted all the models for gender, age, race/ethnicity, BMI categories, perception of fitting in at school, daily screen time, total beverage consumption per week, household food security, whether the family received food stamps, parents’ highest education level, maternal employment status, public versus private school, vending machine availability in school, adolescents’ report of soft drinks for purchase in school, urbanization level, and census region of the school. We imputed missing values of covariates by mean and indicated them by flag variables of missing imputation.

To study the potential modification effect of soft drink availability at school on the associations, we performed stratification analysis by 2 variables: student-reported accessibility to buying soft drinks in school, and administrator-reported availability of vending machines in school.

**RESULTS**

On average, these US eighth graders (mean ±SE age = 14.3 ±0.4 years) consumed soft drinks 5.31 times per week, 8.32 glasses of milk per week, and juice 5.38 times per week (Table 1). Boys drank milk and soft drinks more frequently than did girls. Non-Hispanic Black adolescents drank soft drinks more frequently and Whites drank milk more frequently than did the other racial/ethnic groups. Underweight students drank more milk than
did the other groups. Family food insecurity and receiving food stamps were associated with adolescents’ higher soft drink and lower milk consumption. There was no significant difference in beverage consumption between students in schools with vending machines and those in schools without vending machines.

Adolescents’ soft drink consumption decreased with more MVPA frequency, whereas milk consumption increased (Figure 1). There was a nonlinear relationship between beverage consumption and participation in PE class. Adolescents’ milk consumption increased with frequency of participation in PE class but declined when adolescents participated in PE class more than 3 days per week. Soft drink and juice consumption increased with participation in PE class among students who participated in PE class more than 3 days per week. MVPA increased with frequency of participating in PE class, but this association plateaued among those participating in PE class 3 or more times per week (data available as a supplement to the online version of this article at http://www.ajph.org).

Regression models showed linear relationships between MVPA and milk and soft drink consumption. One more day of MVPA per week was associated with 0.25 to 0.26 fewer times per week of soft drink consumption and 0.19 to 0.21 more glasses per week of milk consumption, after controlling for individual characteristics, family socioeconomic status, and school environmental factors (Table 2). Conversely, the association between participation in PE class and beverage consumption followed a nonlinear pattern. Participation in PE class was associated with fewer soft drinks and more milk consumption among those going to PE class 0 to 2 days per week, whereas the directions of relationship were reversed among adolescents who participated 3 or more days per week. The slopes changed significantly between the 2 ranges (≥3 days/week vs <3 days/week). Juice consumption was significantly associated neither with MVPA nor with participation in PE class.

The stratified analysis shows that school food environment might modify the association of MVPA and PE with beverage consumption (Table 3). The nonlinear relationship between participation in PE class and beverage consumption was only significant in schools having

### TABLE 1—Beverage Consumption by Individual, Family, and School Characteristics Among US Eighth Graders: Early Childhood Longitudinal Study—Kindergarten Cohort, 2007

<table>
<thead>
<tr>
<th>Beverage Consumption</th>
<th>Overall</th>
<th>Student characteristics</th>
<th>Gender</th>
<th>Race/ethnicity</th>
<th>BMI categories</th>
<th>Score of perceived fitting-in</th>
<th>School characteristics</th>
<th>Family characteristics</th>
<th>Region characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>No.(^a)</td>
<td>Mean (SE)</td>
<td>Mean (SE)</td>
<td>Mean (SE)</td>
<td>Mean (SE)</td>
<td>Mean (SE)</td>
<td>Mean (SE)</td>
<td>Mean (SE)</td>
</tr>
<tr>
<td>Soft Drinks (Times/Wk)</td>
<td>5.31 (0.13)</td>
<td>8.32 (0.16)</td>
<td>5.38 (0.14)</td>
<td></td>
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<tr>
<td>Milk (Glasses/Wk)</td>
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<td>Juice (Times/Wk)</td>
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</table>
vending machines or selling soft drinks. In the other schools, participation in PE class was not associated with beverage consumption. However, the interaction terms between a school soft-drink environment and adolescents’ participation in PE class were not statistically significant. Regarding MVPA, the linear associations between MVPA and beverage consumption did not vary much by school soft-drink environment.

**DISCUSSION**

We examined the association of US adolescents’ beverage consumption with physical activity behaviors in 2 ways using nationally representative data. Frequent MVPA was linearly associated with more milk and less soft drink consumption. Interestingly, there was a nonlinear association of participation in PE class with beverage consumption. Compared with the adolescents participating in PE class exactly 3 times per week, adolescents participating in PE class for either more than or fewer than 3 times per week consumed more soft drinks and less milk. This nonlinear association of students’ participation in PE class with beverage consumption was significant in schools selling soft drinks or having vending machines, but it was not significant in the other schools.

The nonlinear association of participation in PE class with beverage consumption persisted after controlling for MVPA. Adolescents’ MVPA did not increase with the frequency of participation in PE class if they participated in PE class 3 or more days per week (data available as a supplement to the online version of this article at http://www.ajph.org). This means the 2 measures reflect different perspectives in the adolescents’ physical activity. While the MVPA indicates adolescents’ overall daily physical activity level, the variable of participation in PE class may additionally reflect adolescents’ interaction with the school environment, including the food and beverage environment, during and after PE class.

Active and inactive children may have different beverage consumption patterns, which can be explained by several factors. For example, active adolescents had better health attitudes and consumed more milk than did inactive adolescents. In addition, active children watched television less frequently and thus were exposed to fewer soft drink advertisements than were inactive children. The clustering of healthier behaviors and habits is evident among adolescents in different countries, which supports our finding that adolescents with more MVPA have healthier beverage consumption. However, high participation in PE class was distinctively associated with higher soft drink and lower milk consumption; there are 2 explanations for this phenomenon.

First, the nonlinear association of participation in PE class with soft drink consumption may result from the food frequency

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**TABLE 1—Continued**

<table>
<thead>
<tr>
<th>Urbanization level</th>
<th>Cities</th>
<th>Suburban and large towns</th>
<th>Small towns and rural</th>
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<tbody>
<tr>
<td></td>
<td>2600</td>
<td>3230</td>
<td>2090</td>
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<tr>
<td></td>
<td>5.52**</td>
<td>4.74 (0.23)</td>
<td>5.82 (0.24)</td>
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<td></td>
<td>(0.24)</td>
<td>(0.23)</td>
<td>(0.24)</td>
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<td></td>
<td>7.93 (0.28)</td>
<td>8.52 (0.27)</td>
<td>8.94 (0.46)</td>
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<td></td>
<td>5.78 (0.27)</td>
<td>5.14 (0.19)</td>
<td>5.07 (0.30)</td>
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</tbody>
</table>

Note. BMI = body mass index; ECLS-K = Early Childhood Longitudinal Study—Kindergarten.

We defined BMI categories on the basis of the US 2000 Centers for Disease Control and Prevention Growth Charts. Underweight: < 5th BMI for age percentile; normal weight: ≥ 5th and < 85th BMI for age percentile; overweight: ≥ 85% and < 95th BMI for age percentile; obese: ≥ 95th BMI for age percentile.

*P < .05; **P < .01; ***P < .001; P values determined by analysis of variance F-test.

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**FIGURE 1—Beverage consumption for US eighth graders by weekly frequency of (a) MVPA and (b) PE class participation: Early Childhood Longitudinal Study—Kindergarten Cohort, 2007.**

Note. MVPA = moderate to vigorous physical activity; PE = physical education. N* is the projected number (in thousands) of eighth graders in the population by MVPA frequency (0–7 days per week) and participation in PE class (0–5 days per week). Beverages studied are soft drinks, juice, and milk.
questions assessing soft drink consumption, which included beverages such as regular soda, non–100% fruit juice drinks, and sports drinks altogether. As the Texas survey showed, adolescents’ participation in PE class was associated with increased flavored sports drinks consumption and with lower consumption of regular soda.23 Thus, when we summed all types of soft drinks to an overall category, the final association of participation in PE class with overall soft drink consumption was nonlinear.

Second, students need to rehydrate after exercise and can choose fluids only from what is available in the environment. The availability of soft drinks or vending machines at schools allowed students to purchase soda and non–100% juice drinks (percentages ranged from 2.9%–54.3% across states).29 Yet, 62.9% of US students in public middle schools had access to sugar-sweetened beverages such as sports drinks, non–100% juice drinks, and regular soda in 2010–2011.23 The distinct figures might come from the less regulated availability of soft drinks with health claims such as sports drinks: about 50.7% of secondary schools allowed students to buy sports drinks (percentages ranged from 8.4%–73.0% across states).29

Regardless of the types of soft drinks, these beverages have other adverse health effects. Acidic and sugar-sweetened sports drinks can cause dental enamel erosion.30 Energy drinks may have less sugar (0–80 kcal/240 ml or 8 oz) than does regular soda (90 kcal/240 ml), but those available in the US market contain stimulants (e.g., caffeine) and electrolytes (e.g., sodium 35–200 mg/240 ml).31 Furthermore, even diet soda consumption is associated with a risk for diabetes32 and may compete with other, healthier options such as milk and plain water consumption.33 Therefore, adolescents’ higher soft drink consumption associated with more participation in PE class may bring health risks that compromise the benefits of physical activity.

We also saw a (statistically insignificant) nonlinear association of students’ participation in PE class with soft drink consumption in schools without vending machines or soft drinks, suggesting that other factors beyond the availability of soft drinks in schools may also influence adolescents’ overall beverage consumption via more participation in PE class. These factors include peers’ beverage preferences34,35 and undesirable quality drinking water in school.36 PE class serves as a venue for student interaction and exchanging preferences among peers, and thus students participating in PE class more frequently may drink the same beverages as do their peers outside school. Moreover, undesirable drinking water quality in school (e.g., dirty water fountains or water with metallic taste, odor, or color) could prevent children’s water usage after physical exercise.

### TABLE 2—Associations of Moderate to Vigorous Physical Activity and Physical Education Class Participation With Beverage Consumption for US Eighth Graders: Early Childhood Longitudinal Study—Kindergarten Cohort, 2007

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<tbody>
<tr>
<td></td>
<td>( b^* ) (95% CI)</td>
<td>( P )</td>
<td>( b^* ) (95% CI)</td>
<td>( P )</td>
<td>( b^* ) (95% CI)</td>
<td>( P )</td>
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<td></td>
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</tr>
<tr>
<td>Model 1: MVPA</td>
<td>-0.25 (-0.35, -0.14)</td>
<td>&lt; .001</td>
<td>0.19 (0.07, 0.30)</td>
<td>.001</td>
<td>0.06 (-0.03, 0.16)</td>
<td>.202</td>
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<tr>
<td>Model 2: Participation in PE class, linear</td>
<td>0.03 (-0.07, 0.13)</td>
<td>.534</td>
<td>-0.09 (-0.2, 0.03)</td>
<td>.149</td>
<td>0.09 (-0.02, 0.19)</td>
<td>.117</td>
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<tr>
<td>Model 3: Participation in PE class, spline</td>
<td>( 0-2 ) d</td>
<td>-0.22 (-0.45, 0.00)</td>
<td>.054</td>
<td>0.12 (-0.11, 0.35)</td>
<td>.306</td>
<td>0.11 (-0.08, 0.29)</td>
<td>.267</td>
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<tr>
<td></td>
<td>( 3-5 ) d</td>
<td>0.38* (0.10, 0.67)</td>
<td>.008</td>
<td>-0.37 (-0.71, -0.02)</td>
<td>.036</td>
<td>-0.02 (-0.27, 0.23)</td>
<td>.889</td>
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<tr>
<td>Model 4: MVPA and participation in PE class</td>
<td>MVPA</td>
<td>-0.26 (-0.37, -0.15)</td>
<td>&lt; .001</td>
<td>0.21 (0.09, 0.33)</td>
<td>&lt; .001</td>
<td>0.06 (-0.05, 0.16)</td>
<td>.275</td>
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<tr>
<td></td>
<td>Participation in PE class 0–2 d</td>
<td>-0.18 (-0.41, 0.04)</td>
<td>.113</td>
<td>0.09 (-0.14, 0.31)</td>
<td>.443</td>
<td>0.10 (-0.10, 0.29)</td>
<td>.325</td>
<td></td>
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<tr>
<td></td>
<td>Participation in PE class 3–5 d</td>
<td>0.43** (0.15, 0.72)</td>
<td>.002</td>
<td>-0.41 (-0.75, -0.06)</td>
<td>.021</td>
<td>-0.03 (-0.29, 0.23)</td>
<td>.822</td>
<td></td>
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</tbody>
</table>

Note. BMI = body mass index; CI = confidence interval; MVPA = moderate to vigorous physical activity; PE = physical education. We adjusted the models for adolescent’s gender, age, race/ethnicity, BMI categories, perception of fitting in at school, screen time, total beverage consumption per wk, household food security, whether the family received food stamps, parental highest education, maternal employment status, public or private schools, vending machine availability in school, adolescent’s awareness of soft drinks for purchase in school, urbanization level, and census region of the school location.

*Estimate from piecewise regression reads as the expected difference in beverage consumption associated with 1 day of participation in PE class, when participation in PE class frequency was 0–2 or 3–5 d/wk. Piecewise specification helps estimate the different slopes for the range 0–2 days per week and for the range 3–5 days per week.

\( *P < .05; **P < .01; ***P < .001; \) testing for difference between 2 slopes for 0–2 vs 3–5 days per week participation in PE class in the piecewise linear regression. For instance, the difference between -0.22 and 0.38 for model 3 for soft drinks was significant at \( P < .05. \)
The competition between water, nutritious beverages such as milk and 100% juices, and less nutritious beverages such as soda and juice punch at the time of meal service has been well acknowledged. The recent nutrition standards of the Hunger-Free Kids Act of 2010 requires schools participating in the National School Lunch Program to provide free potable water during meal service in the lunch area. However, a rare study explored the competition between beverages (including water) after students’ physical activity or PE class. The idea of ‘competitive food and beverages’ should apply beyond the boundary of the school meal program. Future research needs to study the complex relationships between the school’s beverage environment and adolescents’ participation in PE class and their beverage habits.

**Strengths**

Our study has several strengths. First, we applied nonlinear specification to reveal the unexpected relationship between beverage consumption and participation in PE class. This partially supports the data shown in other surveys, and we further explored the role of school environment in this nonlinear relationship. Second, to our knowledge, this is the first study derived from a nationally representative sample to examine the complex association between adolescents’ physical activity and beverage consumption. The phenomenon that high participation in PE class might induce children’s soft drink consumption is a national-as well as a state-level issue.

Although cross-sectional associations cannot imply causality, temporality may not be limited in our study. Fluid intake has a physiological basis; it is a direct consequence of physical activity. It is less probable that children change their beverage consumption patterns to participate in PE class more. Nevertheless, other underlying factors may promote both participation in PE class and beverage consumption. One possible factor is adolescents’ desire to feel accepted by their peers; this desire is associated with both more soft drink consumption and more participation in PE class. However, the nonlinear relationship remained even when our model controlled for adolescents’ perception of fitting in at school.

**Limitations**

Some study limitations should be noted. First, the ECLS-K did not measure soft drink consumption by volume or portion size but by frequency. Nevertheless, the patterns derived from beverage consumption frequency reflect adolescents’ tendency to drink these beverages. Second, the ECLS-K did not measure the amounts of beverages that the study participants drank specifically in school or at home and during or after PE classes. Thus, our data reflect the association of physical activity with overall beverage consumption habits regardless of locations and occasions. Finally, we derived the exposures and outcomes of interest from adolescents’ self-report using the same questions asked in the YRBS. Although the reporting errors of these questions are

| TABLE 3—Associations of Moderate to Vigorous Physical Activity and Physical Education Class Participation With Beverage Consumption, Stratified by Availability of Soft Drinks and Vending Machines in School for US Eighth Graders: Early Childhood Longitudinal Study—Kindergarten Cohort, 2007 |
|---|---|---|---|
| | b (95% CI) | P | b (95% CI) | P | b (95% CI) | P |
| Students can buy soft drinks at school | | | | | | |
| MVPA | -0.23 (-0.37, -0.10) | <.001 | 0.19 (0.03, 0.34) | .018 | 0.04 (-0.09, 0.17) | .516 |
| Participation in PE class 0–2 d | -0.30 (-0.55, -0.05) | .02 | 0.15 (-0.12, 0.43) | .272 | 0.15 (-0.06, 0.35) | .167 |
| Participation in PE class 3–5 d | 0.57*** (0.26, 0.87) | <.001 | -0.68** (-1.01, -0.36) | <.001 | 0.12 (-0.21, 0.45) | .486 |
| Student cannot buy soft drinks at school | | | | | | |
| MVPA | -0.32 (-0.48, -0.15) | <.001 | 0.24 (0.09, 0.40) | .002 | 0.07 (-0.06, 0.20) | .283 |
| Participation in PE class 0–2 d | -0.07 (-0.45, 0.31) | .718 | 0.10 (-0.25, 0.46) | .572 | -0.03 (-0.37, 0.30) | .844 |
| Participation in PE class 3–5 d | 0.22 (-0.29, 0.73) | .39 | 0.01 (-0.55, 0.55) | .999 | -0.22 (-0.54, 0.10) | .183 |
| Vending machine in school | | | | | | |
| MVPA | -0.23 (-0.37, -0.09) | .001 | 0.21 (0.04, 0.38) | .016 | 0.02 (-0.12, 0.16) | .75 |
| Participation in PE class 0–2 d | -0.31 (-0.56, -0.05) | .021 | 0.19 (-0.07, 0.46) | .152 | 0.11 (-0.12, 0.35) | .345 |
| Participation in PE class 3–5 d | 0.57*** (0.25, 0.89) | .001 | -0.69** (-1.07, -0.32) | <.001 | 0.13 (-0.21, 0.46) | .455 |
| No vending machine in school | | | | | | |
| MVPA | -0.31 (-0.51, -0.10) | .003 | 0.20 (0.00, 0.40) | .046 | 0.10 (-0.04, 0.25) | .155 |
| Participation in PE class 0–2 d | -0.01 (-0.39, 0.37) | .957 | -0.04 (-0.40, 0.31) | .806 | 0.05 (-0.28, 0.39) | .745 |
| Participation in PE class 3–5 d | 0.31 (-0.15, 0.78) | .191 | -0.15 (-0.69, 0.40) | .593 | -0.16 (-0.56, 0.24) | .426 |

Note. BMI = body mass index; CI = confidence interval; MVPA = moderate to vigorous physical activity; PE = physical education. We adjusted the models for adolescent’s gender, age, race/ethnicity, maternal employment status, public or private school, vending machine availability in school, awareness of soft drinks for purchase in school, urbanization level, and census region of the school location.

*P < .05; **P < .01; ***P < .001; testing for difference between 2 slopes for 0–2 vs 3–5 d/wk participation in PE class in the piecewise linear regression.
unknown, results in this study can be compared with those from the YRBSS and other surveys that used the same dietary and physical activity questionnaires.

Conclusions
We found a nonlinear association of participation in PE class with beverage consumption among US adolescents, especially in schools with vending machines or otherwise selling soft drinks. This nonlinear association was independent from the linear association between adolescents’ MVPA and healthier beverage consumption patterns. The nonlinear association should be interpreted not as a drawback of promoting physical activity but as the adverse influence of accessibility to competitive beverages in school. That is, PE class is an occasion when students interact with the school environment, including with available healthy and unhealthy food and beverage options.

Although promoting participation in PE class can help increase adolescents’ energy expenditure and thus prevent childhood obesity, the additional energy intake associated with soft drink consumption can offset the benefit. The unintended consequences of consuming more soft drinks and less milk related to frequent participation in PE class might be prevented by replacing soft drinks with quality drinking water in schools. Systematic and well-coordinated intervention approaches are needed to promote healthful behaviors and outcomes in schools.

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Contributors
Hsin-Jen Chen conceptualized and designed the study, conducted the data analysis, and drafted the article. Youfa Wang directed the research, critically reviewed and revised the article, and provided administrative support.

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Human Participant Protection
Because this study was a secondary data analysis of open domain data without any participant identifiers, institutional review board approval was not required.

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