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School food reduces household income disparities in adolescents' frequency of fruit and vegetable intake ☆

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ABSTRACT

Objective: The aim of this study is to examine whether school food attenuates household income-related disparities in adolescents' frequency of fruit and vegetable intake (FVI).

Method: Telephone surveys were conducted between 2007 and 2008 with adolescent-parent dyads from Northern New England; participants were randomly assigned to be surveyed at different times throughout the year. The main analysis comprised 1542 adolescents who typically obtained breakfast/lunch at school at least once/week. FVI was measured using 7-day recall of the number of times adolescents consumed fruits and vegetables. Fully adjusted linear regression was used to compare FVI among adolescents who were surveyed while school was in session (currently exposed to school food) to those who were surveyed when school was not in session (currently unexposed to school food).

Results: Mean FVI was 8.0 (SD = 5.9) times/week. Among adolescents unexposed to school food, household income and FVI were strongly, positively associated. In contrast, among adolescents exposed to school food, FVI was similar across all income categories. We found a significant cross-over interaction between school food and household income in which consuming food at school was associated with higher FVI among adolescents from low-income households versus lower FVI among adolescents from high-income households.

Conclusion: School food may mitigate income disparities in adolescent FVI. The findings suggest that the school food environment positively influences FVI among low-income adolescents.

Introduction

Frequency of fruit and vegetable intake (FVI) in children is a key indicator of dietary quality (United States Department of Agriculture, 2010), associated with decreased risk of chronic disease (Couch et al., 2008; McNaughton et al., 2008), and promoted as part of weight-management guidelines (Epstein et al., 2008; Field et al., 2003; Neumark-Sztainer et al., 2008). The vast majority of U.S. youth consume far fewer fruits and vegetables than the USDA recommends (i.e., for children between 14 and 18, 1.5–2.5 cups of fruit/day and 2.5–4 cups of vegetables/day) (Foltz et al., 2011; Krebs-Smith et al., 2010; Larson et al., 2007; United States Department of Agriculture, 2010). Two recent nationally representative adolescent surveys found that the combined median frequency of fruit (including 100% fruit juice) and vegetable intake was 2.3–2.4 times per day, with the Youth Risk Behavior Survey (YRBS) data showing slightly higher vegetable intake than fruit intake (Centers for Disease Control and Prevention, 2011, 2013).

Recent research examining socioecological influences on child and adolescent dietary intake demonstrated the dual importance of home and school settings (Harrison and Jones, 2012; Sallis and Glanz, 2006; Story et al., 2008; Verloigne et al., 2012). Not surprisingly, studies have consistently demonstrated a positive association between household income and children's fruit and vegetable consumption (Bere et al., 2008; Cutler et al., 2011; Ding et al., 2012; Riediger et al., 2007), due primarily to greater availability of fruits and vegetables in higher

Abbreviations: FVI, Frequency of Fruit and Vegetable Intake; NH, New Hampshire; VT, Vermont; YRBS, Youth Risk Behavior Surveillance Survey.

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income homes (Bere et al., 2008; Berge et al., 2012; Ding et al., 2012; Molaison et al., 2005; Neumark-Sztainer et al., 2003; Rasmussen et al., 2006). In contrast, studies assessing the impact of school food environments on FVI have produced mixed results, showing both positive (Cohen et al., 2012; Cullen et al., 2009; Davis et al., 2009; Slusser et al., 2007) and negative (Briefel et al., 2009; Kubik et al., 2003) associations with FVI, depending on the characteristics of the school food environment. It is not clear whether the impact of school food environments on FVI varies by student socioeconomic status.

The current study was conducted to determine the extent to which school food modifies the known influence of household income on adolescents' FVI. To accomplish this goal, we identified a cohort of adolescents who typically obtained breakfast or lunch at school during the school year. We then compared FVI in two subgroups: those who were randomly allocated to be surveyed during the school year (i.e., currently *exposed* to school food), and those who were randomly allocated to be surveyed during the summer when school was not in session (i.e., currently *unexposed* to school food). This approach, which has not been utilized in prior research on this topic, allowed us to compare exposed and unexposed adolescents who were otherwise comparable in all other respects.

Methods

Study design

Data for this analysis were collected as part of a longitudinal cohort study of adolescent health, approved by the Committee for the Protection of Human Subjects at Dartmouth College. Information on cohort recruitment and survey methods was published previously (Dalton et al., 2006, 2011). Briefly, in 2002–2003, we surveyed 87% of students in grades 4–6 at 26 randomly selected New Hampshire (NH) and Vermont (VT) public schools. Seventy one percent ($N = 2631$) of these students were enrolled in a longitudinal telephone survey of adolescent–parent dyads. Surveys were administered over the phone by trained interviewers. Adolescents and parents were interviewed separately; parental consent and adolescent assent were obtained at each interview. Participants were randomly assigned to be surveyed during different months throughout the year, including summer months when school was not in session. Of the original baseline cohort, 1885 (72%) participated in the 2007–2008 follow-up survey, which provided data for the current study. Follow-up participants were similar to non-participants in terms of gender, age and grade, but were more likely to have higher household incomes ($p < 0.001$) and parents with higher education levels ($p < 0.001$).

Measures

We assessed FVI with a 2-item measure adapted from the YRBS (Centers for Disease Control and Prevention, 2013, 2014). We asked adolescents, "In the past 7 days, how many times did you eat fruits, including fresh or canned?" and "In the past 7 days, how many times did you eat vegetables, including fresh, frozen, canned, and salad, but not including French fries?" For population based studies, Eaton et al. (2013) found that a 7-day recall of the number of times adolescents consumed fruit and vegetables was closest to 24-hour dietary recall estimates of daily servings of fruit and vegetables. Because our results were consistent whether we used fruit, vegetable, or fruit and vegetable intake combined as an outcome, adolescents' responses were summed to indicate the total number of times they ate fruit or vegetables during the previous 7 days.

We also asked all adolescents (regardless of whether they were surveyed while school was in session or not), "In a typical school week, on how many days do you: buy or get breakfast at school? buy or get lunch at school?" Positive responses to these questions were summed to indicate the frequency with which adolescents obtained school food.

Household income was assessed by asking parents to select the category that best described their annual household income from the following list: <$10,000; $10,001–15,000; $15,001–25,000; $25,001–35,000; $35,001–50,000; $50,001–75,000; $75,001–100,000; $100,001–150,000; >$150,000. The first two categories were combined in the analysis due to small sample sizes. Adolescents reported their gender and grade; age was calculated from their date of birth. Adolescent race/ethnicity and participation in free or reduced price lunch at school were assessed through the parent survey. School enrollment and grade configuration were obtained from the Department of Education websites of both states (New Hampshire Department of Education, 2014; Vermont Agency of Education, 2014). School town population size was obtained from the U.S. Census Population Estimates (United States Census Bureau, 2014) and categorized into four groups (<2500; 2500–4999; 5000–9999; ≥10,000).

Comparison groups

Our main purpose was to determine whether school food modified the known influence of household income on adolescents' FVI. Thus, the analysis was based on 1542 adolescents who reported obtaining school food during a typical school week. Adolescents who did not typically obtain food at school ($n = 343$) were excluded from the main analysis. Among adolescents who typically obtained school food, those who were randomly allocated to be surveyed while school was in session were classified as "currently exposed" to school food using two levels: exposed 1–5 times per week (low/moderate); exposed >5 times per week (high). The reference group of "currently unexposed" adolescents comprised those who typically obtained school food but were randomly allocated to be surveyed when school was not in session. Because our choice of comparison groups resembles an experimental design (i.e., all variables remain constant except for current exposure to school food), it minimizes possible bias and confounding, and specifically averts distortions that could arise from including adolescents who never obtain school food, as they likely differ from adolescents who typically obtain food at school (Hastert and Babey, 2009; Stevens et al., 2013).

Statistical analysis

The primary outcome variable was mean FVI. The independent variables of interest were household income and current exposure to school food. We used linear regression to estimate mean FVI. Generalized estimating equations (Liang and Zeger, 1986), with an exchangeable correlation matrix and robust variance estimates (Huber, 1967), were used to account for clustering of adolescents within schools and heteroscedasticity caused by a slightly positive skew in FVI. Adjusted regression models included terms for exposure to school food, household income, and the covariates gender, grade, free/reduced price lunch participation, school enrollment, school grade configuration, and school town population. The final model included a term for the interaction between household income and adolescent school food exposure, in which unexposed adolescents at the lowest income level were the referent group. To explore the robustness of the interaction, we conducted a sensitivity analysis with the 343 adolescents who did not typically obtain school food to determine if the association between household income and FVI was consistent regardless of whether students were surveyed while school was in session or not. In all models, the results were expressed as coefficients representing the expected change in mean FVI for a one unit change in the predictor variable. To maximize the sample size, we employed multiple imputation by chained equations (Azur et al., 2011) to impute values for all variables in the multivariate models with missing data (less than 0.2% of the participants were missing values for adolescent characteristics, 5.5% had a missing value for parent characteristics, and 10.1% were missing values for school/town characteristics). Our results were consistent with and without multiple imputation. All analyses were conducted in 2014 using STATA version 11 (StataCorp LP, College Station, Texas).

Results

Half (52.0%, $N = 804$) the adolescents were male and the majority (94.6%, $N = 1392$) were non-Hispanic white, which reflects the underlying population (Table 1). The mean age for the sample was 14.4 years (SD 1.04). Adolescents attended over 70 schools (34.9% attended 32 schools in NH; 62.2% attended 38 schools in VT; 2.9% attended schools in other states). Schools ranged in enrollment size from 83 to 3329 students, with a mean of 958 (SD = 600). Approximately one-third of the schools were located in settings with less than 5000 residents (school data not shown). Two-thirds ($N = 1043$) of the adolescents were in high school (grades 9–11). Nineteen percent ($N = 280$) received free or reduced price lunch at school. Almost one third ($N = 461$) of parents reported annual household incomes of $50,000 or less; 41.6% ($N = 592$) reported incomes over $75,000. Seventeen percent ($N = 267$) of adolescents were currently unexposed to school food (i.e., surveyed while