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ABSTRACT

Childhood overweight and obesity have increased alarmingly in recent decades all over the world, particularly in middle-income countries like Brazil, Mexico and China. In response to the obesity epidemic, several states and governments have introduced restrictions on sales of high-calorie low-nutrient-dense foods and beverages in schools. However, most school canteens around the world continue to offer such unhealthy products. The lack of clear evidence about the impacts of junk food/beverage availability on childhood overweight potentially contributes to delaying the application of regulatory policies. In fact, sales of junk food represent an important source of revenues for schools, especially in contexts of budgetary pressure. Based on a representative sample of Brazilian middle school students, this article takes advantage of local initiatives that began in 2001 aimed at banning sales of junk food and beverages in schools. Among other effects, instrumental variables estimates show that in-school soft drink availability increases male BMI and overweight risk. As expected, the impacts tend to be stronger on non-poor students. No effect was found for girls, probably because of voluntary substitutions with healthier foods to control total calorie intakes and limit weight gain. Alarmingly, in-school junk food/beverage availability is positively correlated with overall junk food/beverage consumption and negatively correlated with overall healthy food intakes. In conclusion, this article provides clear evidence that banning sales of unhealthy products in schools is a useful tool to fight against the worldwide increase in childhood overweight, even in middle-income countries.

1. Introduction

Childhood overweight and obesity have increased alarmingly in recent decades, not only in rich countries but to an even greater extent in emerging economies. Estimates show that the number of children aged 5 to 19 with obesity increased from 11 million in 1975 to 124 million in 2016 worldwide (Abarca-Gómez et al., 2017). In countries like Brazil, Chile, China, Mexico, Saudi Arabia and USA, the rates are particularly alarming. In Brazil for instance, the 2016 rates of overweight and obesity were 28% and 10.8% for children and adolescents aged 5 to 19. Note that in younger generations (5–9 yo) the rates are even more alarming, reaching 32.4% and 15.1% for overweight and obesity, respectively.[1] A growing corpus of studies demonstrate the negative impacts of childhood overweight and obesity on socioeconomic achievement in future adulthood, excess weight being disproportionally associated with school failure, unemployment, lower wages and socio-psychological troubles (Currie, 2009). In response to the obesity epidemic, several governments around the world have regulated the sale of high-calorie low-nutrient-dense snacks and beverages in schools (e.g. using taxes or bans), for example the case of France and some Canadian provinces, which ban junk food in school canteens. However, junk food is still available in most schools around the world, especially in developing countries where markets are poorly regulated. In fact, this type of intervention is highly controversial insofar as junk food sales represent an important source of revenues, for private firms but also for schools, particularly in contexts of budgetary pressure (Anderson & Butcher, 2006).

The lack of clear conclusions about the impact of junk food regulations on reducing obesity has probably nourished the controversy. While some authors report a positive link between junk food availability in school and excess weight (e.g. Dority et al., 2010), others found no significant correlation (e.g. Taber et al., 2011). These mixed results have methodological explanations. Indeed, most scientific publications only report correlation links that provide no information about the real impacts of junk food availability in schools. Because of nonrandom distribution of regulatory interventions across schools, the relationship between junk food availability and bodyweight is highly endogenous. For example, schools with high obesity prevalence may decide *ex-post* to regulate junk food sales because of public health concerns (i.e. presence of reverse causality). Likewise, schools under strong

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budgetary pressures may decide to continue selling junk foods, but also to reduce or drop gym classes, in order to avoid bankruptcy (i.e. unobserved heterogeneity). Thus, the use of standard multivariate methods such as OLS and Logit estimators will systematically produce biased estimates, even if a comprehensive set of covariates are controlled for.

However, even when a sophisticated identification strategy is implemented to alleviate reverse causality and unobserved heterogeneity, the results reported in the existing literature are mixed. Specifically, two studies rely on instrumental variables (IV) strategies to deal with endogeneity. Anderson & Butcher (2006) use state- and county-level budget variables as instruments to assess the impact of various school regulatory interventions on reported body mass index (BMI) of US adolescents aged from 14 to 20. The authors found that junk food availability in schools increases the students' BMI by around 10 percent. By instrumenting junk food availability by the schools' grade span (i.e. exclusive primary school vs. combined primary and middle schools), Datar & Nicosia (2012) found no significant effect of junk food availability in US elementary schools on children's BMI. By analyzing total consumptions, they argue that offsetting effects could be the cause of this lack of significance, assuming that children from regulated schools consume more junk food at home and/or outside school than children who attend schools where junk food is sold.[2] They conclude that the instruments used by Anderson & Butcher (2006) are relatively weak (i.e. poorly correlated with junk food availability), in addition to potentially not meeting the exogeneity condition (i.e. budget variables are probably correlated with obesity rates in schools). Nonetheless, a recent study did not agree with the results obtained by Datar & Nicosia (2012). Based on a difference-in-differences approach controlling for time-invariant heterogeneity, Leonard (2017) found a negative impact of junk food/beverage bans in Canadian middle and high schools on adolescents' BMI. Interestingly, the author underlined the fact that the effect increased with the duration of the ban: a 5-year ban reduced BMI by 0.3 kg/m2.

To my knowledge, no study has analyzed the nutritional impacts of in-school junk food and beverage ban in the unprecedented context of developing countries. I only found studies that investigate the demand elasticity of soda tax, as implemented in Mexico (e.g. Colchero et al., 2016; Andalón & Gibson, 2017). Though such elasticity models based on household expenditures surveys do not take into account all junk food and beverage purchases. As Andalón & Gibson (2017, p.9) explain: "soda is often bought with 'walking around money' by children going to and from school or by other householders going about their daily business at some location other than the homestead". Moreover, at least two reasons may make the impacts of in-school junk food/beverage ban different between rich economies such as the US or Canada and developing countries. First, nutritional issues are different in developing countries, especially in emerging economies. In the latter, the two burdens of malnutrition concomitantly exist: hunger still persists while overweight rapidly increases (Doak et al., 2000). Second, school canteens are generally poorly regulated in developing countries, allowing vendors to market any products within the schools, especially (profitable) high-calorie low-nutrient-dense snacks and beverages (Lozada et al., 2008; Arya & Mishra, 2013; Gupta et al., 2018). Furthermore, the nutritional impacts of junk food availability might be different between middle school adolescents and primary school children. Indeed, adolescents are more independent, have more control over the foods they consume, and also have more pocket money than their younger peers (Oogarah-Pratap & Heerah-Booluck, 2005). Thus, one can assume that adolescents are more sensitive to the availability of junk food than younger children. This may be why Datar & Nicosia (2012) observed no significant effects in US primary schools. However, one can also assume that adolescents are more able to leave school campuses to access other sources of junk food (i.e. convenience stores, fast-food restaurants), and so might be less affected by a junk food ban in school.

Hence, this article aims to fill the literature gap by applying a similar methodology to that used by Datar & Nicosia (2012) to a rich cross-sectional database in Brazil collected in 2015. The recent alarming increase in childhood obesity in these regions makes this study highly relevant. Brazil appears to be a perfect study area given the great heterogeneity of junk food bans in schools. Since 2001, five states have introduced local laws regulating sales of foods and beverages with high-calorie and low-nutrient density in school canteens (Jaime & Lock, 2009). Despite the emergence of such local initiatives, many states continue to offer junk food and beverages in school canteens, probably to avoid a significant loss of revenues. Another input of the present study is distinguishing between boys and girls, for whom the nutritional impact of junk food availability may differ. Surprisingly, potential gender-based differences were ignored in previous studies, except in Leonard (2017) who found stronger impacts on girls.[3] Similarly, I originally investigate the potential presence of heterogeneous effects according to family economic backgrounds. The impacts of bans are expected to be stronger for non-poor adolescents, since the amount of pocket money children receive theoretically correlates with family economic backgrounds. Finally, the study contributes to the existing literature by considering several junk food items sold within schools, such as soft drinks, baked products, processed salty snacks, candy and chocolate. Generally, previous studies focused on only one junk food item (e.g. soda) or on a composite index (e.g. availability of any junk food item).

From a practical point of view, I use a nationally representative database of Brazilian middle school students in 2015. For each school, this survey includes detailed information on the school environment and the food supply collected from school administrators. At the student level, the survey includes reported data about family backgrounds and diet, as well as objective measurements of height and weight. Given the cross-sectional structure of the database, I implement an IV strategy based on the school's grade span to deal with potential endogeneity problems. Like Datar & Nicosia (2012) but applied to different school grades, I use the exogenous distribution of combined middle and high schools to infer the impact of junk food availability on BMI and overweight risk among middle school students. While junk foods are significantly more available in combined schools than in exclusive middle schools, I assume no direct correlation between combined school attendance and nutritional outcomes. To explore potential heterogeneous effects according to gender, I run separate regressions for boys and girls. Likewise, I investigate wealth-related heterogeneous effects by running alternative IV regressions that distinguish poor from non-poor students using an index of family owned assets. Finally, to better understand the transmission pathways, I run OLS regressions to estimate how school junk food bans influence the total food and beverage consumptions of students (in- and out-of-school).

[1] Data publicly available in the WHO website (section: global health observatory data repository). Generally, both nutritional statuses are calculated from the body mass index, which is equal to weight in kilograms divided by the square of height in meters. The cut-off of 25kg/m^2 is used for classifying overweight people while the cut-off of 30kg/m^2 is used for classifying obesity (WHO, 2000). Both statuses are gradually associated with chronic diseases such as high blood pressure, diabetes mellitus and cancers, in addition to other health and psychological troubles like sleeping apnea, bad brain oxygenation and depression (WHO, 2006). For children, the same cut-offs are used but BMI values are previously adjusted in z-scores for age and gender given important metabolic disparities during growth (WHO, 2006).

[2] The existence of such compensatory behaviors concerning unhealthy eating habits are also demonstrated in Lichtman-Sadot (2016) and Fletcher et al. (2010).

[3] Unfortunately, possible pathways for gender-specific results are not discussed by the authors. In this article, I describe potential theoretical pathways in the discussion.

In Brazil, IV estimates show positive and significant impacts of junk food availability in middle schools on BMI and overweight risk for boys only. The effects of soft drinks and processed salty snacks (e.g. chips) were stronger. In terms of socioeconomic heterogeneity, higher impacts are observed among non-poor students, who are more likely to obtain pocket money from their parents than poorer students. For girls, I only found a positive correlation between in-school candy and chocolate availability and excess weight. However, this correlation is not robust and disappears after IV correction. Then, the analysis of overall food consumptions highlights hazardous substitution behaviors induced by the availability of junk food/beverage in Brazilian middle schools. Indeed, when available in school, students tend to use soft drinks and processed salty snacks as substitutes for complete and diversified meals including healthy foods such as fruits, vegetables and beans.

The rest of the article is organized as follows. In section 2, I describe the data and methods. In section 3, I comment the results and finally, in section 4, I conclude and make recommendations for public policies.

2. Methods

2.1. Data

I used the data from the second sample of PeNSE 2015 (National Survey for Health of Students). Designed by the Brazilian Institute of Geography and Statistics (Portuguese acronym IBGE) and the Health Ministry, and supported by the Education Ministry, this cross-sectional survey is the third (the two first were conducted in 2009 and 2012). Sample 2 of PeNSE 2015 is representative of the Brazilian population in the first grade of middle school (*6° ano do ensenino basico*) to the highest grade of high school (*3° ano do ensenino medio*). In total, the sample includes 371 public and private schools and around 16,000 students. The survey was directly administered to students in the form of a numerical questionnaire and provides a wealth of information on health-related events and behaviors, as well as on family backgrounds such as owned assets and maternal education. In addition, it provides clinical data such as height and weight of individuals (measured by professionals using standard equipment in a dedicated session).[4] Finally, the survey includes school-level data collected thanks to school authorities.

2.2. Empirical strategy

Notwithstanding the richness of the PeNSE database, the identification of causal effects involves notable statistical complications. Due to potential endogeneity problems, standard OLS or probit regressions of nutrition outcomes on junk food availability in school is likely to provide erroneous estimates, despite controlling for observable characteristics. More specifically, two sources of endogeneity may interfere in this relationship. First, reverse causality problems may bias ordinary multivariate estimates since schools reporting high rates of childhood overweight and obesity could decide *ex-post* to ban the sales of junk food within their institution. Such an overrepresentation of overweight students who were only recently unable to access junk food at school, might understate the positive impact of junk food availability on nutritional status. If such food regulations are widespread in the school sample, OLS/probit estimates might misreport a negative correlation between junk food availability and overweight risk, or perhaps a null correlation. A second source of endogeneity is the presence of unobserved heterogeneity. Indeed, schools that serve junk food may differ in many characteristics correlated with nutritional outcomes of students compared to schools that meet healthier nutritional guidelines. Even if some characteristics are observed and controlled for, such as sociodemographic factors, a substantial proportion of them are hardly observable and consequently often omitted. Datar & Nicosia (2012) mention several generally omitted determinants that influence the decision to serve junk food and which might also correlate with students' bodyweight, such as budgetary pressures, food demand and preferences of the student population, parental involvement, and regional policies. According to the authors, budgetary pressures are particularly important in this decision because junk food is a non-negligible source of revenue for schools. In addition, in some cases, budgetary pressures may lead school authorities to partially or totally drop physical education programs. Hence, the omission of strong budgetary pressures experienced by certain schools may bias the fitted impact of junk food availability on childhood overweight. If budgetary pressures are positively correlated with in-school junk food sales but negatively correlated with the length of gym class, thus OLS or probit estimators will overstate the positive impact of junk food availability on childhood overweight. In contrast, if budgetary pressures increase the need to sell junk food in school in order to fund gym class and other school infrastructures related to physical activity (e.g. playgrounds), thus OLS or probit estimators will understate the positive impact of junk food availability on childhood overweight.

To alleviate potential endogeneity problems and assess causal effects, I implement an identification strategy inspired by Datar & Nicosia (2012). Comparing elementary and middle/high schools, the authors demonstrate that junk food availability increases with schools' grade span, and thus concludes that combined school attendance represents a useful IV. The underlying idea is to use the assumed exogenous distribution of combined schools to capture variations in junk food availability that are not related to the nutritional status of students. To be valid as instrument, the school's grade span should not affect student bodyweights other than transiting through the junk food environment. In Brazil, Table 1 clearly shows that junk food availability is twice higher in combined middle/high schools than in exclusively middle schools. Hence, I use the distinction between combined middle/high schools and exclusive middle schools in Brazil as an instrument. Several tests are discussed later as arguments for the validity of the instrument.

Table 1
Description of the sample of middle school students and availability of junk food in school canteens (%) according to grade span.

	Exclusive middle schools (N = 138)	Combined middle and high schools (N = 129)
Total number of students	5410	4580
Number of students in grade 6	1512	1071
Number of students in grade 7	1686	1356
Number of students in grade 8	1415	1189
Number of students in grade 9	797	964
Percent of school canteens that sell [...]		
Baked products (e.g. cookies)	11.69	31.21
Soft drinks	13.28	34.27
Processed salty snacks (e.g. chips)	18.49	26.61
Candy and chocolate	14.51	28.43

Source: PeNSE 2015 sample 2.

[4] This is not the case of the first sample of PeNSE 2015, which includes > 100,000 students in the last grade of middle school (*9° ano do ensenino basico*).

Let's consider two-stage least squares (2SLS) estimations as follows:

$$\begin{cases} JF_j = \alpha_0 + \alpha_1 CS_j + \alpha_2 X_i + \alpha_3 S_j + \alpha_4 A_k + \vartheta_i \\ Y_i = \beta_0 + \beta_1 \widehat{JF}_j + \beta_2 X_i + \beta_3 S_j + \beta_4 A_k + \varepsilon_i \end{cases}$$

The first stage regresses junk food availability (*JF*) in middle schools j on combined school attendance (CS_j) and individual (X_i), school (S_j) and area (A_k) characteristics. The second stage regresses nutritional outcomes (*Y*) of students i on the fitted junk food availability from the first-stage ($\widehat{JF}_j$) and covariates.

2.3. Variables and sample

2.3.1. Nutritional outcomes

One advantage of the PeNSE database is the collection of objective measurements of weight and height. Thanks to the two anthropometric measurements, two nutritional outcomes (Y_i) are analyzed in this study. First, I consider the body mass index (BMI) adjusted for age and gender using the WHO (2006) correction (z-score). Before the z-score adjustment, the BMI is equal to weight in kilograms divided by squared height in meters. Second, I use the childhood overweight status from the BMI clinical classification directly measured by the survey staff using the WHO (2006) correction (i.e. underweight vs. normal-weight vs. overweight). For each nutritional outcome, I systematically perform gender-specific regressions to limit comparison and measurement errors. The BMI distribution is known to differ between boys and girls, especially during body growth episodes (WHO, 2006).

2.3.2. Junk food/beverage availability

'Junk food and beverages' refers to consumable products containing high concentrations of sugar, fat and/or sodium with low-nutrient density. In the PeNSE database, junk food and beverage availability in schools (JF_j) was directly collected from the school administrators. They were asked if the school canteen sells different groups of food and beverage items, such as soft drinks, processed salty snacks (e.g. chips), baked goods (e.g. cookies), candy and chocolate. For each beverage and food item, the variable takes the value 1 when the item is available in the school canteen, otherwise 0. I also consider a dummy of junk food and beverage availability that takes the value 1 when any item (i.e. soft drinks, processed salty snacks, baked goods, candy or chocolate) is available in the school canteen, otherwise 0.

2.3.3. Instrument and sample restriction

The instrument is built by distinguishing middle schools that also provide high school instruction from middle schools that do not provide high school instruction. Specifically, this dummy variable takes the value 1 if a middle school is combined with a high school in the same institution and place, otherwise 0. Since the identification strategy relies on differences in junk food availability between combined middle/high schools and exclusive middle schools, I restricted the sample to middle school students (N = 9,990, see Table 1). In other words, once the dummy variable that identifies whether a middle school is combined or not was built, I excluded high school students from the sample. Consequently, the restricted sample is only representative of the Brazilian population enrolled in middle schools in 2015. The exclusion of high school students could be considered as a scientific loss but this procedure is necessary for the identification of a causal effect.[5] In Table 1, note that the proportion of combined schools is relatively high in the sample: 5,410 middle school students enrolled in 138 exclusive middle schools versus 4,580 middle school students enrolled in 129 combined middle/high schools.

2.3.4. Control variables

To control for observable heterogeneity, several individual, school and area characteristics are considered, like in the model of Datar & Nicosia (2012). Individual characteristics (X_i) include sociodemographic and economic factors such as age (in years), race (white, black, Asian, mixed, or Amerindian), household size, the mother's education level (no formal education, basic education, intermediate education, higher education, or not known), and the family wealth index (a 5-score index summing the five following assets if owned: a landline at home, a personal cell phone, a computer at home, Internet access at home, and a car owned by the household). Then, school (S_j) and area (A_k) characteristics include a dummy that distinguishes public from private schools, area urbanicity and regions. Note that the inclusion of school- and area-specific characteristics controls for important predictors of the decision to combine middle and high schools, which may also correlate with students' BMI. For example, childhood overweight prevalence varies across rural and urban areas, as well as across regions. Similarly, certain regions and localities have a stronger probability of combining different grades in the same structure for various reasons, such as the size and distribution of the surrounding school-age population, specific education systems and programs, or budgets allocated to education expenditures. In theory, poor and less populated localities, with specific childhood overweight prevalence, would be expected to have a higher likelihood of collectivizing different teaching grades in a single school.

Descriptive statistics of the sample according to grade span are shown in Table A1 in the Appendix.

2.4. Validity of instruments

To be valid, an instrument must meet two conditions: (i) be a strong predictor of the endogenous regressor; (ii) not directly affect the unexplained variations in outcome indicators. The first condition is easily testable. As shown in Table 2, first-stage IV regressions systematically showed a positive and significant relationship between combined school attendance and junk food/beverage availability in the canteens of Brazilian middle schools. For instance, a middle school student enrolled in a combined school has a probability of having access to soft drinks and processed salty snacks around 20 percentage points higher than a middle school student enrolled in an exclusive middle school. Moreover, F-statistics on excluded instruments are systematically significant, except for the availability of processed salty snacks in the girls' sample (Table 2).

The exogeneity condition requires that the school's grade span does not directly affect student food intakes and physical activity except through variations in junk food availability, conditional on covariates and area-specific dummies. Even if this assumption is not directly testable, several indirect tests help to make an instrument more convincing. The first concern is a potential selection bias regarding combined school enrollment. One can assume that one type of student, with a specific bodyweight status, disproportionally enroll in exclusive middle schools rather than in combined schools. In theory, such pre-existing differences between students who attend combined or exclusive schools should still be observable with respect to current education and health outcomes not related to junk food availability or to current BMI. Thus, to test for such a selection bias, I regressed combined school attendance on current health and education outcomes which depend more on students' pre-existing characteristics than on junk food availability (i.e. future schooling intentions, tooth pain dummy, and height-

[5] Combined school attendance is non-significantly correlated to junk food availability among high-school students (results available upon request).

Table 2
IV first-stage regression (OLS estimates).

	Availability of any junk food		Availability of soft drinks		Availability of baked products		Availability of processed salty snacks		Availability of candy and chocolate	
	BOYS	*GIRLS*	*BOYS*	*GIRLS*	*BOYS*	*GIRLS*	*BOYS*	*GIRLS*	*BOYS*	*GIRLS*
Combined school attendance (dummy)	0.252***	0.212***	0.230***	0.211***	0.191**	0.149**	0.166**	0.109	0.141**	0.118**
	(0.075)	(0.075)	(0.064)	(0.060)	(0.075)	(0.068)	(0.076)	(0.073)	(0.058)	(0.056)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,876	4,773	4,876	4,773	4,876	4,773	4,876	4,773	4,876	4,773
R-squared	0.325	0.337	0.270	0.305	0.146	0.127	0.118	0.088	0.091	0.104
F-statistics on excluded instruments	11.19***	7.96***	12.70***	12.36***	6.50**	4.83**	4.76**	2.24	5.88**	4.52**

Notes: Each column represents a separate regression. All control variables and fixed effects are included. Each regression is weighted using students sample weights provided in the database. Standard errors are clustered at the school level. Robust standard errors are in parentheses. Levels of significance are *** 1%, ** 5%, * 10%.
Source: PeNSE 2015 sample 2.

for-age), conditional on covariates.[6] As shown in Table 3a, once controlled for observed characteristics, the probability of attending combined school is uncorrelated with pre-existing health outcomes (e.g. height-for-age), or with current health status (e.g. tooth pain) or future schooling intentions. Hence, this balance test rejects the assumption of a selection bias between combined and exclusive middle schools. Both types of schools are assumed to be comparable regarding pre-existing student characteristics, conditional on covariates.

Furthermore, one could assume that area specificities influence the decision for local authorities or school administrators to collectivize middle and high schools (Datar & Nicosia, 2012). For example, area characteristics such as public transportation, infrastructures or criminality index may explain why school grades are combined in a same place, while in the same time such characteristics might influence fast-food density around school as well as physical activity, food intakes and nutritional status of children. Likewise, one could speculate that combined schools are disproportionally located in small and low-income municipalities, in order to create economies of scale in contexts of budgetary pressure. Such a behavior would be problematic for the validity of instruments since schools with limited revenues may drop or reduce some educational contents, which then might increase children's BMI, such as gym class. However, Table 3b shows that several factors related to school environment (e.g. occurrence of violent events in the school area, school wealth index, length of gym class, and presence of ambulant food sellers around school) is statistically balanced between exclusive elementary school and combined schools. Even if there is no information about area population density or transportation facilities in the database, one can consider that school wealth index (based on 15 owned assets), criminality-related indicators, and fast-food availability around school, are good proxies for the general school environment.

Another concern is a potential bias due to stronger hazardous peer-effects in combined middle/high schools compared to exclusive middle schools. Indeed, in combined schools, potential riskier behaviors of high school students may influence the behaviors of middle school students, which could affect their current BMI via other pathways than junk food availability. For example, focusing on an European adolescent sample, Gwozdz et al. (2019) show that overweight individuals tend to influence peers' behavioral patterns, namely in terms of unhealthy food consumption and physical inactivity. It is well known that food-related risky behaviors (e.g. junk food consumption) are strongly correlated with non-food risky behaviors (e.g. smoking, alcohol consumption, etc.) (Chiolero et al., 2008). Hence, Table 3c estimates how combined school attendance influences risky non-food behaviors (i.e. already smoked tobacco, already drunk alcohol, age of the first sexual relation, and use of a condom in the first sexual relation) among the sample of middle school students. Table 3c shows no significant correlation, except for smoking behaviors which are lower in combined middle schools than in exclusive middle schools. Similarly, Table 4 suggests that high school students have healthier behaviors than middle school students in Brazil. High school students have a lower z-score BMI, lower overweight risk and consume a similar amount of soft drink and salty snacks per week than middle school students. Hence, in the case of Brazilian combined schools, potential peer-effects regarding unhealthy food behaviors are unlikely to overstate the impact of junk food availability on BMI.

Table 3a
Combined school attendance, schooling intention and health outcomes (balance tests 1).

	Post-grade school intention	University intention	Tooth pain	Height-for-age
	(1)	(2)	(3)	(4)
Combined school attendance	0.003	0.005	0.005	0.037
	(0.017)	(0.020)	(0.013)	(0.040)
Control variables	Yes	Yes	Yes	Yes
Observations	9,896	9,896	9,850	9,900
R-squared	0.088	0.082	0.014	0.156

Notes: Each column represents a separate OLS regression. Each dependent variable is a dummy, except for height-for-age which is a z-score. All control variables and fixed effects are included. Each regression is weighted using students sample weights provided in the database. Standard errors are clustered at the school level. Robust standard errors are in parentheses. Levels of significance are *** 1%, ** 5%, * 10%.
Source: PeNSE 2015 sample 2.

One remaining issue that may violate the exogeneity condition of instruments is the question of whether food served in combined school is different than in exclusive middle schools, beyond just junk food and beverage. It is likely that the size of served meals is larger in combined schools because of a higher average age of students. Unfortunately, there is no data about the size of meals served by school canteens to

[6] The height-for-age indicator is adjusted for gender based on the WHO (2006) correction (z-score). In the economics literature, the BMI is considered to be a short-term indicator of health status, since weight depends strongly on current consumption and lifestyle. By contrast, height is considered a long-term indicator of health status, as it strongly reflects nutritional status and maternal risk behaviors from gestation to early childhood (Thomas, Strauss, and Henriques, 1991).

Table 3b
Combined school attendance and school environment (balance tests 2).

	Neighborhood dangerousness index	Number of class interruptions	School wealth index	Length of sports class per day (min.)	Presence of ambulant food sellers around school
	(1)	(2)	(3)	(4)	(5)
Combined school attendance	−0.191	−0.048	0.182	−0.147	−0.039
	(0.208)	(0.109)	(0.372)	(0.150)	(0.082)
Control variables	Yes	Yes	Yes	Yes	Yes
Observations	9,903	9,903	9,903	8,669	9,903
R-squared	0.100	0.082	0.233	0.055	0.052

Notes: Each column represents a separate OLS regression. All control variables and fixed effects are included. Each regression is weighted using students sample weights provided in the database. Standard errors are clustered at the school level. Robust standard errors are in parentheses. Levels of significance are *** 1%, ** 5%, * 10%.
The neighborhood dangerousness index, reported by the school administrators, captures how often last year was the school area considered as risky in terms of violence (robberies, thefts, shots, drug use, homicides, etc.). This 5-point Likert index varies from never to every time. Likewise, the school administrators reported the number of times, last year, did the school have to suspend or interrupt its classes for reasons of safety because of area violence. The school wealth index is a 15-score composite index of school assets summing the following assets (if owned) in good condition: a library, a computer room, Internet access, a sports field, a running track, a swimming pool, sports equipment, lockers, extra-curricular sporting activities, accessibility for handicapped students, a lunch service, a kitchen, a vegetable garden, and potable water.
Source: PeNSE 2015 sample 2.

Table 3c
Combined school attendance and non-food risky behaviors (peer-effect test).

	Already smoked tobacco	Already drunk alcohol	Age of first sexual relation	Use of condom in first sexual relationship
	(1)	(2)	(3)	(4)
Combined school attendance (dummy)	−0.031**	−0.001	−0.052	0.018
	(0.014)	(0.019)	(0.122)	(0.041)
Control variables	Yes	Yes	Yes	Yes
Observations	9,896	9,896	1,313	1,324
R-squared	0.105	0.225	0.270	0.039

Notes: Each column represents a separate regression. In columns 1, 2 and 4, the dependent variables are dummies. In column 3, the dependent variable is continuous. For each regression, OLS estimators are used (i.e. linear probability models in columns 1, 2 and 4). All control variables and fixed effects are included. Each regression is weighted using students sample weights provided in the database. Standard errors are clustered at the school level. Robust standard errors are in parentheses. Levels of significance are *** 1%, ** 5%, *10%.
Source: PeNSE 2015 sample 2.

test this potential issue. Nonetheless, among students attending middle school, Table A1 in the Appendix shows no significant difference regarding total food and beverage consumptions between combined schools and exclusive middle schools. It means that grade span does not affect the variety of diets. By extrapolation, one might assume that grade span neither affects the size of meals served in school canteens. Because the latter assumption is relatively heavy, it is worth noting that this potential issue is an important limitation of this article.

Table 4
Summary statistics per school grade.

	Middle school				High school		
	6th grade	7th grade	8th grade	9th grade	1st grade	2nd grade	3rd grade
Number of students	2583	3043	2604	1761	2383	2438	1736
Average age (in years)	11.55	12.49	13.27	14.26	15.41	16.11	17.15
Overweight rate (%)	32.48	30.64	28.61	27.31	23.92	23.38	23.10
Average z-score BMI-for-age	0.49	0.47	0.42	0.37	0.29	0.24	0.24
Weekly consumption of soft drinks (# of days)	2.58	2.82	2.94	2.94	3.03	2.80	2.64
Weekly consumption of snacks (# of days)	2.78	2.87	3.11	3.17	3.40	3.53	3.28

Source: PeNSE 2015 sample 2.

2.5. Placebo tests

I check the robustness of the results by using falsification/placebo tests. A first placebo test executes the same IV strategy except that BMI is replaced by another health outcome for which no effect is expected. In theory, height-for-age should be uncorrelated with junk food availability since growth potentials are determined before school starting age.

A second placebo test runs IV estimates of junk food items on the student's physical activity, in- and out-of-school. Theoretically, junk food availability cannot directly affect children's physical activity, except perhaps if students compensate for the availability of junk food in schools by exercising more outside of school (i.e. a positive link between availability of junk food and total physical exercise). In any case, if fitted coefficients appear as non-significant, it would mean that omitted factors such as budgetary pressures do not bias the fitted impact of junk food availability on BMI.[7]

A third placebo test executes the same IV strategy except that junk food availability is replaced by the availability of healthier beverages in school canteens. In theory, the availability of healthy goods has no significant impact on overweight, or perhaps a negative impact if students

[7] As explained by Datar & Nicosia (2012), junk food sales represent an important source of revenues for schools. Hence, under strong budgetary pressures, school administrators might decide to continue selling junk food and drop some expenditures related to physical activity (e.g. length of gym class). Paradoxically, junk food sales may help to fund gym class or school infrastructures giving more opportunity for physical opportunities such as playgrounds or sport fields. Thus, since the effect of budgetary pressure on children' physical activity is unclear, the bias direction is also ambiguous. The omission of budgetary pressure may either understate or overstate the positive impact of junk food availability on students' BMI, by respectively increasing or decreasing the length of gym class and physical activity.

use healthy snacks purchased in school (e.g. natural juices and fruits) as a substitute for unhealthy consumptions.

3. Results

Fig. 1 illustrates the distribution of BMI-for-age among middle school students. Note that the BMI distribution strongly depends on gender and socioeconomic backgrounds, which justifies the relevance to separately analyze boys and girls, and to investigate potential heterogeneous effects according to family wealth. While girls are overrepresented between 0 and 0.2 z-score (i.e. a moderated excess weight), boys are overrepresented in the highest BMI values (i.e. childhood overweight and obesity). Regarding socioeconomic backgrounds, children from favorable families tend to be fatter than children from under-privileged households.

3.1. Impacts of junk food availability on BMI-for-age and overweight

Table 5 shows the estimates for male and female middle school students. Complete tables are available in Tables A2 to A5 in the Appendix. It is reassuring to note that the significance of fitted coefficients from OLS regressions is generally confirmed in IV regressions (at least for boys), although IV estimates are less precise than OLS estimates (see confident intervals in Table 5).

Among boys, Table 5 shows positive and significant impacts of the availability of any junk food in middle schools on BMI-for-age. Disaggregating the analysis by junk food/beverage item, the fitted effects are stronger for soft drinks, processed salty snacks and baked goods. For instance, OLS estimates indicate that, among boys, potential exposure to soft drinks in middle school increases BMI-for-age by 0.20 z-score unit (+43%) and overweight risk by 8.4 percentage points (+27%). In IV estimates, once controlled for potential endogeneity problems, soft drink availability increases BMI-for-age by 0.48 z-score unit (+104%) and overweight risk by 12.9 percentage points (+0.41%). Note that the fitted effects of processed salty snacks and baked goods availability are a bit lower and less precise. Among girls, junk food availability has no significant impact on female BMI, as shown in Table 5. OLS regressions indicate positive correlations between candy/chocolate availability and female excess weight (+33%). This result is consistent with the results obtained by Oogarah-Pratap & Heerah-Booluck (2005), showing that girls have a particular preference for candy and chocolate, while boys prefer salty snacks. However, once corrected for unobserved heterogeneity and reverse causality, these correlations do not remain significant.

In addition to gender-based differences, Table 6 shows another source of heterogeneous effects. Indeed, IV estimates suggest that the positive impact of junk food availability on overweight risk tend to be stronger in non-poor adolescents than in their poorer peers. The latter result makes sense insofar as students need money to buy snacks and soft drinks in school.

As supplementary robustness checks, the results of three placebo tests are shown in Tables 7a, 7b and 7c. As expected, Table 7a consistently shows no impact of junk food availability on height-for-age, in either boys or girls. Similarly, Table 7b suggests that junk food availability has no impact on children's physical activity, neither within nor out-of-school. Finally, Table 7c indicates that greater access to healthy beverages in school such as natural juice has no effect on BMI and overweight risk. The insignificance of the placebo tests means that there is no evidence against the validity of instrument.

3.2. Junk food availability in school and total food consumption

Table 8 reports OLS regressions estimating how junk food availability in middle schools does influence students' total consumption with respect to various food and beverage items. Not surprisingly, soft drink availability in school is positively correlated with the students' total soft drink consumption. Contrary to the assumption developed by Datar & Nicosia (2012) in the context of US primary schools, Brazilian adolescents do not consume at home or outside school (or do not bring from home) the junk food/beverage they cannot purchase in school due to prohibitions. Given the absence of such offsetting mechanisms, junk food/beverage bans in Brazilian middle schools are likely to have a real beneficial impact on the students' total consumption. Conversely, Table 8 alarmingly emphasizes that the availability of both soft drinks and processed salty snacks in school are negatively correlated with the overall consumption of healthy foods (e.g. fruits, vegetables, and/or beans), especially for girls.[8] Thus, as explained by Arya & Mishra (2013), soft drinks and processed salty snacks, when available in school canteens, might be used by adolescents as substitutes for other calorie sources, particularly as substitutes for healthy foods.[9]

4. Discussion

Existing empirical studies that assessed the impacts of junk food availability in schools on students' nutritional status produced mixed results in the US. What is more, to date, no study has focused on the case of emerging countries, where childhood overweight and obesity rates have increased alarmingly in recent decades. Consequently, using a recent and rich database in Brazil (PeNSE 2015), this article fills this literature gap by assessing the effects of the availability of soft drinks and processed salty snacks in middle school canteens on students' BMI-for-age and overweight risk. In addition, compared to the existing literature on the topic, this work is innovative in that it explores potential heterogeneous effects according to gender and socioeconomic status. Indeed, stronger effects for boys and non-poor students are expected. To address endogeneity problems, I used an IV procedure inspired by Datar & Nicosia (2012) that takes advantage of the exogenous distribution of combined middle/high schools in Brazil. Several tests checked the internal and external validity of this instrument, which seems to be highly correlated with the endogenous regressors and exogenous to unobserved variations in nutritional outcomes.

As observed by Anderson & Butcher (2006), Dority et al. (2010) and Leonard (2017) among US and Canadian adolescents, both OLS and IV estimates show positive effects of junk food availability in Brazilian middle schools on BMI-for-age and overweight risk. In terms of magnitudes, the results from Table 5 are consistent with Dority et al. (2010) and Leonard (2017) who respectively find that availability of junk food and beverage increases overweight risk by 18 percentage points in the US, and BMI until 0.34 units for boys and 0.42 units for girls in Canada. However, contrary to Leonard (2017), the effects in Brazil are only significant for boys. Likewise, IV estimates in Brazil show stronger impacts than observed in the US by Anderson & Butcher (2006), which find that availability of any junk food in US schools might increase BMI by only 10% (against an increase by 94% in Table 5).

[8] Similar findings were found between other junk food items (i.e. baked goods, candy and chocolate) and total intakes of healthy foods (e.g. beans, fruits and vegetables).

[9] A slight negative correlation is found between the availability of processed salty snacks in school and total fast food consumption among boys. This might mean that, when available in school canteens, male students prefer to spend money on consuming such snacks in school rather than consuming fast-foods outside school, on average.

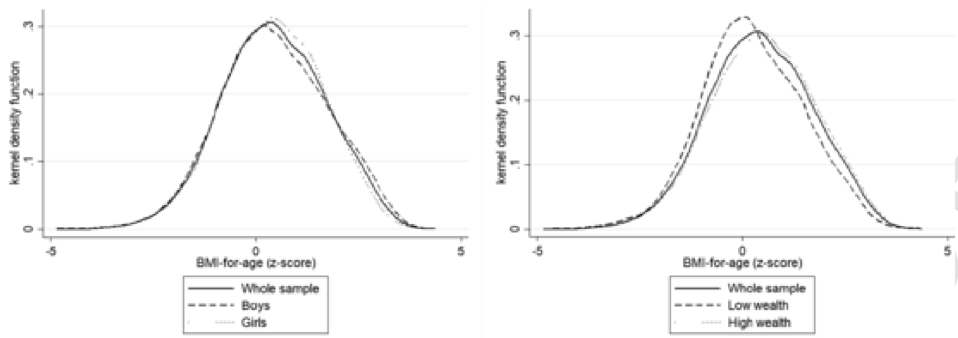

Fig. 1. Distribution of BMI-for-age by gender and family wealth index. Source: PeNSE 2015 sample 2.

Table 5
Effects of junk food availability in middle schools on BMI and overweight.

	BOYS				*GIRLS*			
	BMI-FOR-AGE		OVERWEIGHT		BMI-FOR-AGE		OVERWEIGHT	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Availability of any junk food	0.152***	0.436*	0.051**	0.117	0.029	−0.213	0.018	−0.060
	(0.055)	(0.223)	(0.021)	(0.075)	(0.071)	(0.302)	(0.023)	(0.093)
	0.044–0.259	*−0.001–0.874*	*0.009–0.093*	*−0.030–0.265*	*−0.112–0.170*	*−0.804–0.378*	*−0.028–0.064*	*−0.242–0.122*
Availability of soft drinks	0.200***	0.480**	0.084***	0.129*	−0.085	−0.214	−0.024	−0.060
	(0.063)	(0.243)	(0.025)	(0.078)	(0.086)	(0.294)	(0.028)	(0.089)
	0.076–0.324	*0.003–0.956*	*0.035–0.133*	*−0.024–0.282*	*−0.255–0.085*	*−0.790–0.362*	*−0.080–0.032*	*−0.236–0.115*
Availability of baked products	0.080	0.577*	0.030	0.155	0.084	−0.302	0.036	−0.085
	(0.066)	(0.344)	(0.023)	(0.114)	(0.081)	(0.447)	(0.032)	(0.135)
	−0.050–0.211	*−0.097–1.252*	*−0.015–0.075*	*−0.069–0.379*	*−0.076–0.244*	*−1.178–0.575*	*−0.028–0.100*	*−0.349–0.179*
Availability of processed salty snacks	0.128**	0.665*	0.032	0.179	−0.010	−0.413	−0.000	−0.117
	(0.059)	(0.395)	(0.023)	(0.126)	(0.076)	(0.616)	(0.028)	(0.187)
	0.012–0.243	*−0.110–1.440*	*−0.013–0.076*	*−0.067–0.425*	*−0.161–0.140*	*−1.620–0.795*	*−0.055–0.055*	*−0.484–0.251*
Availability of candy and chocolate	0.082	0.780	0.022	0.210	0.142**	−0.380	0.052**	−0.107
	(0.059)	(0.493)	(0.022)	(0.160)	(0.071)	(0.570)	(0.023)	(0.173)
	−0.034–0.199	*−0.186–1.746*	*−0.021–0.065*	*−0.104–0.524*	*0.001–0.283*	*−1.497–0.736*	*0.007–0.096*	*−0.447–0.232*
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,875	4,875	4,876	4,876	4,772	4,772	4,773	4,773
Sample mean of dependent variables	0.46		0.31		0.43		0.30	

Notes: Each row and each column represent a separate regression (linear probability models when overweight status is considered as outcome). In IV estimates, combined school attendance is used as instrument. All control variables and fixed effects are included. Each regression is weighted using students sample weights provided in the database.
Standard errors are clustered at the school level. Robust standard errors are in parentheses. Confidence intervals are in italics. Levels of significance are *** 1%, ** 5%, *10%.
Source: PeNSE 2015 sample 2.

For girls, no significant impact was found, which is consistent with the fact that young women tend to adopt a healthier diet than boys. Indeed, the social pressure related to thinness ideals is particularly strong for girls in Latin America (Mancilla-Díaz et al., 2012). In facts, boys generally have a higher propensity to consume junk food and beverages than girls (Morse & Driskell, 2009). An interesting study focusing on subjects in Mauritius observed that boys tend to prefer salty packaged snacks, while girls have a stronger preference for candy, chocolate and fresh fruits (Oogarah-Pratap & Heerah-Booluck, 2005). A stronger BMI decrease for boys was also found in the assessment of school programs requiring a minimum number of minutes of physical education (Cawley et al., 2013). The authors conclude that boys tend to use gym class as a complement, while girls use it as a substitute for out-of-school activities. Likewise, one can assume that boys use in-school junk foods and beverages as a complement to "in-home" consumption, while girls use unhealthy products purchased in school as a substitute for other sources of calories (perhaps to limit weight gain).

In line with this assumption, I observed that junk food availability in middle schools is associated with hazardous substitution effects in students' consumptions, especially among girls. In schools where junk foods and beverages are available, students tend to use high-calorie low-nutrient-dense products as substitutes for healthy foods like fruit and vegetables, and beans. The responsibility of such substitution effects in the unprecedented increase of childhood overweight was already suspected by Arya & Mishra (2013) among Indian schoolers. As explained by the authors, in-school junk food and beverage intakes may result in major changes in dietary intakes, by reducing (or even stopping) healthy meals' intakes, either at school or at home. Hence, regarding the rapid, recent but unequal increase of childhood overweight in emerging countries such as India or Brazil, it is not so surprising that the nutritional effects of in-school junk food availability are stronger than those observed in the US, where bodyweight variations among children are lower (Doak et al., 2000).

Table 6
Heterogeneous effects according to family wealth index (IV estimates).

	POOR (wealth index < = 2)		NON-POOR (wealth index > = 3)	
	BMI-FOR-AGE	OVERWEIGHT	BMI-FOR-AGE	OVERWEIGHT
Availability of any junk food	−0.387	−0.247	0.222	0.085*
	(0.887)	(0.349)	(0.156)	(0.051)
Availability of soft drinks	−0.258	−0.165	0.254	0.098*
	(0.545)	(0.171)	(0.187)	(0.058)
Availability of baked products	−0.406	−0.259	0.322	0.124
	(0.920)	(0.364)	(0.238)	(0.085)
Availability of processed salty snacks	−0.728	−0.466	0.367	0.141
	(1.938)	(0.897)	(0.287)	(0.098)
Availability of candy and chocolate	−0.539	−0.345	0.416	0.160
	(1.193)	(0.420)	(0.330)	(0.113)
Control variables	Yes	Yes	Yes	Yes
Observations	2,549	2,550	7,098	7,099
R-squared	0.038	0.023	0.026	0.022

Notes: Each row and each column represent a separate IV regression using a 2SLS estimator. Boys and girls are analyzed conjointly. The poor sample is composed of students whose wealth index is below or equal to 2, while the "non-poor" sample is composed of students whose wealth index is above or equal to 3. The family wealth index is a 5-score indicator summing the five following assets if owned: a landline at home, a personal cell phone, a computer at home, Internet access at home, and a car owned by the household. Combined school attendance is used as instrument. All control variables and fixed effects are included. Each regression is weighted using students sample weights provided in the database. Standard errors are clustered at the school level. Robust standard errors are in parentheses. Levels of significance are *** 1%, ** 5%, *10%.
Source: PeNSE 2015 sample 2.

Table 7a
Effect of junk food availability in middle schools on height-for-age (placebo test 1).

	BOYS		*GIRLS*	
	OLS	IV	OLS	IV
Availability of soft drinks	0.003	0.010	−0.074	0.180
	(0.073)	(0.220)	(0.060)	(0.262)
Availability of baked products	−0.046	0.013	−0.018	0.254
	(0.058)	(0.266)	(0.062)	(0.381)
Availability of processed salty snacks	0.005	0.015	−0.086	0.348
	(0.066)	(0.306)	(0.059)	(0.573)
Availability of candy and chocolate	−0.058	0.017	−0.025	0.320
	(0.063)	(0.358)	(0.058)	(0.471)
Control variables	Yes	Yes	Yes	Yes
Observations	4,873	4,873	4,773	4,773
R-squared	0.177	0.177	0.173	0.167

Notes: Each row and each column represent a separate regression. IV refers to just-identified IV estimates, using combined school attendance as instrument. All control variables and fixed effects are included. Each regression is weighted using students sample weights provided in the database. Standard errors are clustered at the school level. Robust standard errors are in parentheses. Levels of significance are *** 1%, ** 5%, *10%.
Source: PeNSE 2015 sample 2.

Thanks to the exploration of heterogeneous effects, this study enables a better understanding of the ambiguous results in the literature. Indeed, one can assume that Datar & Nicosia (2012) failed to demonstrate a significant impact of junk food availability in US primary schools on students' BMI because they did not consider gender and socioeconomic heterogeneity. In fact, when boys and girls were conjointly analyzed in the same sample, neither significant effect stood out in Brazilian middle schools.[10] Moreover, there are two further possible explanations for the lack of significance in the Datar & Nicosia (2012) IV estimates. First, the authors focused on a sample of primary school students, who are supposed to have less pocket money to spend on junk food and beverages than middle school students (Oogarah-Pratap & Heerah-Booluck, 2005). Second, the authors built a dummy indicator of in-school junk food/beverage availability taking the value 1 if students can purchase at least one of the following items in school, otherwise 0: candy, chocolate, baked goods like cookies, processed salty snacks, ice cream, frozen yogurt and soft drinks. Hence, the potential impact of certain junk food/beverage items, such as soft drinks and processed salty snacks, could be lessened by the exclusive availability of other snacks weakly correlated with students' BMI (see Table 5).

4.1. Recommendations for public policies

To conclude, these results have important implications for public policy. Despite the related loss of revenues for schools, banning junk food/beverage in schools significantly contributes to the fight against childhood overweight in Brazil, at least for boys. In particular, the sales of soft drinks and salty snacks in schools appear strongly hazardous insofar as students tend to use high-calorie low-nutrient-dense products as substitutes for complete and diversified meals. Hence, the regulation policy implemented in five Brazilian states since 2001 have a conclusive impact and should be generalized to the rest of the nation. Moreover, I recommend to other countries where junk foods remain available in schools to limits their sales to fight against the childhood obesity epidemic. However, restriction policies rather than tax policies should be preferred. Since the weight gain induced by junk food availability is positively correlated with students' socioeconomic backgrounds, taxing junk food in schools might only have an impact among low-income students. Moreover, the health impact of junk food taxes is often mitigated because of potential substitution effects with similar untaxed items (Yaniv et al., 2009; Franck et al., 2013). Obviously, cost-effectiveness analyses should be implemented to assess if the reduction in overweight among boys offsets the loss of school revenues from junk food sales. For girls, other sets of interventions should be explored to fight against obesity. Some studies suggest that girls might be more concerned by prevention programs than boys (Morse & Driskell, 2009). Further research should estimate the impact of such programs on nutrition and health behaviors considering potential gender-based heterogeneous effects. Finally, instead of implementing local interventions (e.g. at the school level), global anti-obesity policies are recommended for better efficiency, avoiding potential out-of-school offsetting effects. As shown by Lichtman-Sadot (2016), soft-drink bans in US high schools are associated with an increase in total household soda consumption.

[10] Full-sample regressions are available upon request. Note that Leonard (2017) observed the same trends in Canada.

Table 7b
Effect of junk food availability in middle schools on physical activity (placebo test 2).

	BOYS								*GIRLS*							
	Length of sport class per day		Length of physical activity per day (outside school)		Days per week of intense physical activity (>60mn)		Hours of sedentary activity per day (outside school)		Length of sport class per day		Length of physical activity per day (outside school)		Days per week of intense physical activity (>60mn)		**Hours of sedentary activity per day (outside school)**	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV	OLS	IV	**OLS**	**IV**
Availability of soft drinks	0.050	0.526	0.147	0.823	−0.162	0.077	−0.226	−0.556	−0.161	−1.203	−0.198	0.012	−0.089	−0.231	0.057	−0.428
	(0.200)	(0.683)	(0.133)	(0.505)	(0.144)	(0.496)	(0.183)	(0.516)	(0.242)	(0.967)	(0.178)	(0.591)	(0.131)	(0.518)	(0.224)	(0.710)
Availability of baked products	0.100	0.662	−0.075	0.960	−0.187	0.093	0.145	−0.671	−0.254	−1.778	−0.017	0.016	−0.187	−0.328	0.137	−0.601
	(0.171)	(0.860)	(0.127)	(0.700)	(0.138)	(0.600)	(0.156)	(0.693)	(0.206)	(1.639)	(0.164)	(0.830)	(0.138)	(0.757)	(0.178)	(1.029)
Availability of processed salty snacks	−0.018	0.737	−0.110	1.168	−0.166	0.107	−0.167	−0.767	−0.245	−2.478	0.024	0.022	0.025	−0.447	0.054	−0.818
	(0.192)	(0.989)	(0.135)	(0.941)	(0.121)	(0.692)	(0.149)	(0.763)	(0.212)	(2.564)	(0.161)	(1.105)	(0.130)	(1.050)	(0.162)	(1.443)
Availability of candy and chocolate	−0.131	0.936	−0.101	1.239	−0.183	0.126	0.090	−0.900	−0.565**	−2.336	−0.188	0.023	−0.131	−0.419	0.213	−0.780
	(0.200)	(1.259)	(0.180)	(0.820)	(0.128)	(0.812)	(0.198)	(0.963)	(0.235)	(1.919)	(0.178)	(1.192)	(0.148)	(0.923)	(0.219)	(1.378)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,254	4,254	3,744	3,744	4,851	4,851	4,857	4,857	4,179	4,179	3,071	3,071	4,735	4,735	4,748	4,748
R-squared	0.049	0.044	0.056	0.045	0.024	0.023	0.080	0.079	0.089	0.068	0.091	0.090	0.035	0.035	0.071	0.067

Notes: Each row and each column represent a separate regression. IV refers to just-identified IV estimates, using combined school attendance as instrument. All control variables and fixed effects are included. Each regression is weighted using students sample weights provided in the database. Standard errors are clustered at the school level. Robust standard errors are in parentheses. Levels of significance are *** 1%, ** 5%, *10%.
Source: PeNSE 2015 sample 2.

Table 7c
Effect of healthy beverage on overweight risk and BMI-for-age (placebo test 3).

	BOYS				GIRLS			
	OVERWEIGHT		BMI-FOR-AGE		OVERWEIGHT		BMI-FOR-AGE	
	OLS	IV	OLS	IV	OLS	IV	OLS	IV
Natural fruit juices	0.014	0.208	0.023	0.772	−0.011	−0.133	−0.058	−0.469
	(0.020)	(0.163)	(0.060)	(0.514)	(0.026)	(0.202)	(0.081)	(0.674)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,873	4,873	4,875	4,875	4,873	4,873	4,772	4,772
R-squared	0.177	0.177	0.058	0.011	0.177	0.177	0.022	0.004

Notes: Each row and each column represent a separate regression (linear probability models). IV refers to just-identified IV estimates, using combined school attendance as instrument. All control variables and fixed effects are included. Each regression is weighted using students sample weights provided in the database. Standard errors are clustered at the school level. Robust standard errors are in parentheses. Levels of significance are *** 1%, ** 5%, *10%.
Source: PeNSE 2015 sample 2.

Table 8
Junk food availability in middle schools and total food/beverage consumption.

	Total soft drink	Total fruit	Total vegetable	Total beans	Total fritters	Total candy and chocolate	Total processed food	Total fast-food
BOYS								
Availability of soft drinks in school (dummy)	0.203†	−0.242**	−0.084	−0.069	0.043	0.112	−0.105	−0.069
	(0.133)	(0.113)	(0.152)	(0.132)	(0.120)	(0.137)	(0.113)	(0.101)
Availability of processed salty snacks in school (dummy)	−0.155	−0.246**	−0.032	−0.204	−0.048	0.127	−0.262**	−0.199**
	(0.139)	(0.118)	(0.153)	(0.202)	(0.117)	(0.140)	(0.130)	(0.088)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,869	4,867	4,867	4,869	4,872	4,866	4,861	4,868
Sample mean of dependent variables	2.90	3.45	3.61	4.70	1.81	3.14	2.90	1.10
GIRLS								
Availability of soft drinks in school (dummy)	0.255*	−0.539***	−0.522***	−0.336**	0.067	0.208	0.177	0.062
	(0.132)	(0.140)	(0.128)	(0.131)	(0.113)	(0.131)	(0.136)	(0.095)
Availability of processed salty snacks in school (dummy)	0.049	−0.328**	−0.296	−0.478***	0.009	0.100	0.061	0.010
	(0.140)	(0.161)	(0.180)	(0.163)	(0.119)	(0.150)	(0.166)	(0.098)
Control variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,766	4,767	4,770	4,765	4,765	4,767	4,767	4,766
Sample mean of dependent variables	2.76	3.41	3.68	4.32	1.87	3.71	3.04	1.07

Notes: Each row and each column represent a separate OLS regression. Dependent variables about total food/beverage consumption captures the number of days the food/soda item was consumed during the last 7 days (it varies from 0 for no consumed to 7 for a daily consumption). All control variables and fixed effects are included. Each regression is weighted using students sample weights provided in the database. Standard errors are clustered at the school level. Standard errors are in parentheses. Levels of significance are*** 1%, ** 5%, *10%, †15%.
Source: PeNSE 2015 sample 2.

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