A Water Availability Intervention in New York City Public Schools: Influence on Youths' Water and Milk Behaviors

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Objectives. We determined the influence of "water jets" on observed water and milk taking and self-reported fluid consumption in New York City public schools.

Methods. From 2010 to 2011, before and 3 months after water jet installation in 9 schools, we observed water and milk taking in cafeterias (mean 1000 students per school) and surveyed students in grades 5, 8, and 11 (n = 2899) in the 9 schools that received water jets and 10 schools that did not. We performed an observation 1 year after implementation (2011–2012) with a subset of schools. We also interviewed cafeteria workers regarding the intervention.

Results. Three months after implementation we observed a 3-fold increase in water taking (increase of 21.63 events per 100 students; $P < .001$) and a much smaller decline in milk taking (-6.73 events per 100 students; $P = .012$), relative to comparison schools. At 1 year, relative to baseline, there was a similar increase in water taking and no decrease in milk taking. Cafeteria workers reported that the water jets were simple to clean and operate.

Conclusions. An environmental intervention in New York City public schools increased water taking and was simple to implement. (*Am J Public Health.* 2015;105: 365–372. doi:10.2105/AJPH.2014.302221)

Water intake is essential for many human biological and biochemical processes.[1] To maintain a body water balance, the National Academy of Sciences recommends adequate intake level for water in any form (solid foods and beverages including plain water) for adolescents aged 14 to 18 years at 3.3 liters per day for boys and 2.3 liters per day for girls.[1] According to the 2005–2006 National Health and Nutrition Examination Survey, adolescent boys aged between 14 and 18 years consumed 2.89 (95% confidence interval [CI] = 2.65, 3.13) liters of water and girls consumed 1.97 (95% CI = 1.84, 2.10) liters of water on average.[2] Both were below the recommended cutoff. In addition, studies have shown that hydration is associated with improved memory recall,[3,4] and fluoridated water intake with the prevention of dental caries.[5]

Drinking water is a healthy no-calorie replacement for sugar-sweetened beverages (SSBs),[6] which have been linked to obesity, dental caries, and displacement of nutrient-rich foods among children.[7–9] Decreasing the daily amount of SSBs consumed is associated with lower total caloric consumption and reduced obesity prevalence.[10,11]

In New York City, the obesity rate among young children (kindergarten through 8th grade) is nearly 21%.[12,13] To address this, New York City has recently implemented a multifaceted approach to obesity reduction and prevention that includes an initiative to encourage water consumption, including a mayoral requirement that all city agencies, childcare centers, and public schools have water available at all meals. As part of the Healthy, Hunger Free Kids Act passed by Congress in 2010,[14] all schools are required to make plain drinking water available to students at no cost during the lunch meal periods in the locations where meals are served, and during the School Breakfast Program when breakfast is served in the cafeteria. Furthermore, the US Department of Agriculture has proposed a new rule to implement local school wellness policies to provide water and maintain water fountains in schools.[15]

In 2008, pursuant to a mayoral executive order, New York City became the first major city in the country to mandate a set of food and beverage nutrition standards governing all city agencies, including public schools. This policy included procurement, service, and vending standards. Beverage vending in schools limited calories to 10 calories per 8 ounces in elementary schools and 25 calories per 8 ounces in high schools with no artificial sugar added. To meet the city's goal of increasing student water consumption, in 2010 the Fund for Public Health in New York, an arm of the New York City Department of Health and Mental Hygiene (DOHMH), received funding to provide "water jets" (drinking water dispensers) to 140 schools across the city from the Communities Putting Prevention to Work grant from the Centers for Disease Control and Prevention. Water jets are large, clear plastic jugs with push levers that dispense cooled, aerated tap water (similar to slushy machines found in convenience stores) that are placed near the lunch line in the school cafeteria. To assess the impact of the new water jets, New York University, the DOHMH, and the Centers for Disease Control and Prevention conducted an evaluation during the 2010–2011 school year with a subset of 9 schools that received the water dispensers and 10 comparison schools. The water jets were installed with no other school-based activities to promote water drinking; disposable cups were available next to the jet at all schools. We note that New York City water is delivered from sources in upstate New York essentially lead-free, but because lead introduction is possible from pipes, water in schools is periodically tested.

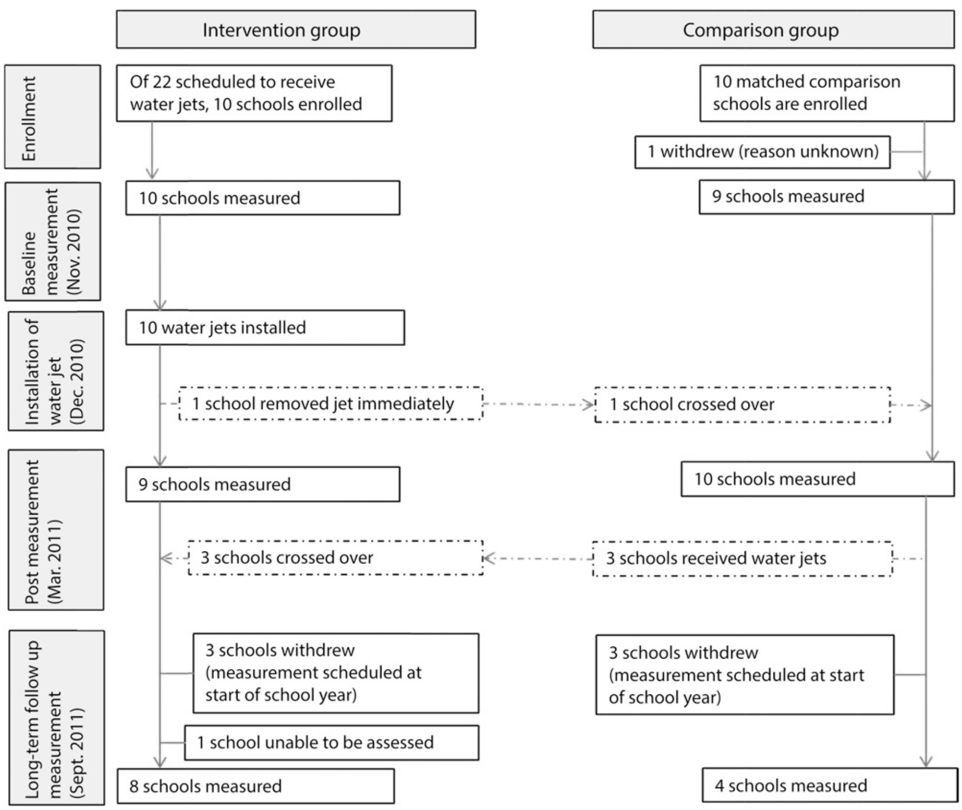
Previous studies (using mainly self-report data or studies based in Europe) have provided preliminary evidence that water in schools could prevent overweight and help children maintain healthy weight.[16–18] Potential changes in milk intake as result of increased water availability are a potential concern, however, because of the nutrients that milk confers to children. The current study, to our knowledge, is the first to look at the impact of providing elementary-school students, middle-school students, and high-school students with increased water access, with no promotions or parallel interventions. Thus, this evaluation study set out to address 4 research objectives: (1) determine whether the introduction of water jets increases students' objectively measured taking of water for consumption, (2) determine whether the introduction of water jets has an impact on the students' taking of milk for consumption, (3) evaluate whether the introduction of water jets improves students' opinions of water, and (4) assess the cafeteria staff's experience with the water jets.

METHODS

We identified all schools within the New York City school district that were scheduled to receive a water jet in November 2010 (based on expression of interest by the school and having appropriate electrical outlets to support the machine) for inclusion in the study (n = 22). Principals in 10 of these schools were reached by the DOHMH and agreed to be part of the study. We then created a pool of other New York City public elementary, middle, and high schools not scheduled to receive a water jet in the 2010–2011 school year, matched by grade level to the participating schools. The pool included the following publicly available school characteristics for each school: grades served, total student population, percentage of students below the poverty level, and percentage of Black, Asian, and Hispanic students.[19] Using these variables, for each of the participating schools, we calculated the "Euclidean distance"[20] between the school and every school not scheduled to receive a water jet.

The Euclidean distance is a method used to assess the degree of similarity between observations in regards to a set of defined characteristics. To calculate Euclidean distance, variable values are converted to *z* scores, and differences between *z* scores are squared and summed. The square root of this sum is the Euclidean distance.

This value summarized the similarities between the schools, to allow for comparison to choose the most similar school for the control. The DOHMH then contacted the principals at potential "comparison" schools in similarity order until a principal consented to be part of the study. Just before baseline data collection, one comparison school chose not to be in the study. As noted subsequently, one of the intervention schools did not continue with installation of their water jet. This school was retained in the study and assigned to the comparison group. These final sample changes resulted in a total of 9 intervention and 10 comparison schools in the study (Figure 1). Following selection of schools, we observed whether the intervention and comparison schools had a water fountain available (8 intervention schools and 9 comparison schools did somewhere in the cafeteria) and a location to purchase bottled water (5 intervention schools and 7 comparison schools).



Note. Six schools (3 intervention, 3 comparison) decided not to participate in the long-term follow-up, as follow-up observations were scheduled to occur soon after the school year began. One additional school was not assessed because of staffing reasons, and 3 additional comparison schools received a water jet over the summer.

FIGURE 1—Schools participating in each wave of data collection: New York City, 2010–2011.

Data Collection and Research Design

We collected data via 3 methods: cafeteria observations, student surveys, and interviews with cafeteria managers. Our design included data collection from intervention and comparison schools at 3 points: preintervention (baseline in November 2010) directly before water jets were installed, approximately 3.5 months after installation (March 2011), and 10 months postintervention (September 2011), after the beginning of a new school year. Our design used a quasi-experimental approach to examine the effect of the water jets on observed water and milk taking and self-reported fluid consumption.

Cafeteria observations. We observed the cafeterias of each school during all lunch periods on 2 days both before and after water jet installation (approximately 40 000 student observations per round). Groups of 2 to 4 trained research assistants counted the number of times the water jet was used (if there was one), the number of times the other water sources in the cafeteria were used (all possible water sources were observed in each period of data collection), and the number of times milk was taken from the lunch line. For each time point, each cafeteria was usually observed on 2 consecutive days, with the matched comparison school observed on approximately the same days. In addition, during the next school year (2011–2012), we conducted a long-term follow-up round of observations at a subset of 12 of the participating schools to assess whether the effects of the water jets were sustained into the next year (approximately 13 000 students observed). Six schools (3 intervention, 3 comparison) declined to participate in the long-term follow-up, generally because the observations were scheduled to occur too soon after the school year began. We were unable to assess 1 school for staffing reasons, and 3 of the comparison schools received a water jet over the summer. These 3 schools were coded as having a water jet in the second period, as in a crossover design. However, an intent-to-treat analysis did not substantively change the results. The observation methods for this follow-up round were identical to those of the earlier rounds (Figure 1).

Student surveys. We surveyed all students in grades 5, 8, and 11 at participating intervention and comparison schools in their homeroom classroom about their water drinking behaviors, opinions, and beliefs about water before and after water jet installation. To the best of our knowledge, no teachers refused to distribute the survey, and all students that were administered a survey completed the survey. We chose grade 5 to represent elementary schools because the oldest students in the school were expected to be the best able to remember and record their responses correctly; we selected grades 8 and 11 by using a 3-year increment to maximize the age spread and include 1 grade from each school level. Two schools, a matched pair of high schools, declined to administer the student surveys for a total of 17 participating schools. The surveys were administered by the students' classroom teachers during the same week that the cafeteria observations were completed.

The survey asked students how many times they drank a glass or bottle of plain water the previous day, what they usually drank at lunch on a typical school day, and whether they agreed or disagreed that they like the taste of tap water, that it is safe to drink, and that it is healthy. Questions about consumption frequency were generally based on modified questions from the Youth Physical Activity and Nutrition Survey.[21] For the students in schools with a water jet, a set of questions regarding the jet were also asked. These included whether they noticed the water jet, how often they used it, where the water in the jet comes from, whether they liked the taste of the water, whether the water is safe, and whether they drink more water now that the jet is there. Unlike the observations, the surveys were not administered for a second follow-up in the subsequent school year.

Cafeteria manager interviews. At the time of the first round of post–water jet data collection, a trained interviewer from the DOHMH conducted structured interviews with the cafeteria managers in each intervention school. The interviews included a mix of quantitative and open-ended questions about their experiences with the water jets, implementation and maintenance, and student interaction with the jets.

Data Analysis

We used a difference-in-difference approach to analyze the cafeteria observation and student survey data.[22] This method compares the change over time in the intervention group with the change during the same time period in a comparison group. The difference between these 2 changes is attributed to the effects of the intervention, because the comparison group behavior over time represents a plausible counterfactual that controls for other factors that might influence water drinking, such as seasonal changes or public health campaigns.

Cafeteria observations. We estimated Poisson models for the observed number of water-taking (either water jet, water fountain, or purchased water) or milk-taking events during all school lunch periods in a given day by using the number of students in attendance on the day of observation as the denominator (offset), and school type (high school or middle school vs elementary school) as a control variable. Each school contributed 2 days of observations in each (pre- or postintervention) period, with clustering at the school level. For observed events, we calculated predicted counts for every 100 students in attendance. We also calculated models with pair fixed effects (including separate covariates for each school "pair," largely equivalent to a conditional logit), and results did not differ substantially from the results presented (the water results were the same, and the milk results were in the same direction, somewhat smaller in magnitude, and no longer significant).

Student surveys. We analyzed survey data by using ordinary least squares regression for the reported number of glasses of water drunk the day before the survey and by using logistic regression for the following binary outcomes: drinks water at lunch most days; drinks milk at lunch most days; agreed with "I like the taste of tap water"; agreed with "It is safe to drink water that comes straight from a faucet or tap in New York City"; and agreed with "Tap water is healthy." We controlled models of survey data outcomes for gender, race/ethnicity, and grade of the student. We estimated all models as difference-in-differences, and they contained indicators for time period, program group, and their interaction. The coefficient on this interaction represented the program impact. We calculated robust standard errors that adjusted for clustering at the school level.

We also estimated logistic regression models in the intervention schools only for whether the student reported noticing the water jet, and conditional on noticing the water jet for the following: reported that they "drink water from the new water machine in the cafeteria" "occasionally" or "every day"; agreed with "I like the taste of the water that comes out of the new water machine in the cafeteria"; agreed with "I drink more water

TABLE 1—Demographic Characteristics of Comparison and Intervention Schools Compared With All New York City Public Schools: 2009

School Characteristics	All New York City Public Schools, No. or Mean (SD)	Comparison Schools, No. or Mean (SD)	Intervention Schools, No. or Mean (SD)
Number of schools	1497	10	9
Average number of students per school	656.1 (549.6)	1174.7 (898.9)	1091.1 (849.6)
Race/ethnicity, %			
African American	35.3 (28.2)	13.4 (10.2)	21.4 (12.6)
Hispanic	40.8 (25.4)	32.5 (16.7)	40.5 (20.9)
Asian	10.7 (16.3)	19.5 (14.1)	10.9 (10.9)
White	12.1 (18.9)	33.2 (24.7)	25.1 (28.2)
Students eligible for free or reduced-price meals, %	64.4 (24.5)	47.1 (22.7)	54.1 (27.6)
Female, %	48.7 (9.4)	51.6 (7.7)	55.3 (16.9)

Notes. Demographic information for schools was provided by the Department of Education for the year 2009.[19] Significance testing was conducted between the intervention schools and the comparison schools; no differences were significant.

now that the water machine is in the cafeteria"; and agreed with "It is safe to drink water that comes from the water machine."

Cafeteria manager interviews. We analyzed the structured interviews with cafeteria managers by using counts for the quantitative questions and a simple set of codes for the very limited number of open-ended qualitative questions, which was created inductively through close reading of all of the responses. We entered all responses into a Microsoft Excel 2010 database and a single member of the research team created and applied the codes.

RESULTS

The participating schools averaged about 1000 students each. Two of the intervention schools were kindergarten through 5th-grade schools, 3 were kindergarten through 8th grade, 1 was kindergarten through 12th, 1 was 6th through 12th, and 2 were 9th through 12th. Each comparison school served identical grades to the matched intervention school.

Approximately half of the students at the participating schools qualified for free or reduced-price meals (Table 1). A range of races/ethnicities was represented; intervention schools had 21% African American students, 41% Hispanic students, 25% White students, and 11% Asian American students. About half of the students were female. The demographics of the comparison schools were similar. Participating schools were somewhat larger on average than NYC schools, and had more White and fewer African American students. Surveys were collected from 2899 students (Table 2). From the pre- to postintervention period in both intervention and comparison schools, there was

TABLE 2—Demographic Characteristics and Differences Pre- and Postintervention of Surveyed Students, by Intervention and Comparison Schools: New York City Public Schools, 2010–2011

	Comparison Schools (n = 1250)				Intervention Schools (n = 1649)				Difference Between Comparison and Intervention Schools	
Characteristic	Pre	Post	Change	P	Pre	Post	Change	P	Δ	P
Race/ethnicity, %										
White	39.0	34.7	−4.3	.102	29.7	22.9	−6.8	.003	−2.5	.457
Black	9.5	9.2	−0.3	.895	14.0	13.6	−0.4	.806	−0.1	.951
Hispanic	31.7	29.1	−2.6	.325	40.0	41.9	1.9	.438	4.5	.211
Asian	17.4	20.0	2.6	.2	10.6	12.8	2.2	.215	−0.4	.878
Other	1.2	2.4	1.2	.249	4.5	5.0	0.5	.559	−0.7	.626
Grade, %										
5th	48.4	42.1	−6.3	.02	38.5	30.6	−7.9	.001	−1.6	.676
8th	21.4	26.2	4.8	.065	35.3	40.1	4.8	.034	0.0	.997
11th	29.3	29.7	0.4	.868	25.7	25.8	0.1	.974	−0.3	.917
Gender, %										
Boys	47.6	45	−2.6	.353	48.3	47.2	−1.1	.664	1.5	.678
Girls	52.4	55	2.6	.353	51.7	52.8	1.1	.664	−1.5	.678
Sample size, no.	665	585			849	800				

TABLE 3—Regression Models for Short-Term Follow-Up Results on Water- and Milk-Taking Events Pre- and Postintervention, by Comparison and Intervention Schools: New York City, 2010–2011

	Comparison Schools (n = 10)				Intervention Schools (n = 9)				Program Impact	
Variable	Pre	Post	Change	P	Pre	Post	Change	P	Impact	P
Water-taking events for every 100 students observed, all schools	6.62	8.69	2.07	.015	10.11	33.81	23.70	<.001	21.63	<.001
Milk-taking events for every 100 students observed, all schools	39.38	38.39	−0.99	.536	31.05	23.33	−7.72	.001	−6.73	.017

Notes. Total sample size was n = 19 schools. Analysis from Poisson models in which the dependent variable was the number of water- or milk-taking events and the number of students in attendance on the day of observation was the denominator. Statistics were rescaled to "100 students observed" by dividing "margins" output by average school attendance, derived either from a simple average, or by dividing the predicted count (from margins) when all independent variables are 0, by the constant term from incidence-rate ratio Poisson output. Models control for the percentage of the school that is African American, the percentage of the school that is male, the percentage of the school that receives free meals, and the grade levels that were observed.

a decrease in 5th-grade respondents and an increase in 8th-grade respondents, and no difference in gender.

With the exception of 1 school that removed the water jet after 1 day because they found it too messy (and was subsequently included as a comparison school in our analysis), all intervention schools had the water jet in place throughout the postintervention period of the study. All schools provided cups and all students were allowed to serve themselves from the machines.

Cafeteria Observation Data

Impact on observed water taking. Table 3 shows results of the cafeteria observations. We observed a nearly 3-fold increase in the number of water-taking events at intervention schools after the water jets were installed. At baseline (before water jet installations), there were 10.11 water-taking events per 100 students in attendance on the day of observation from a source in the cafeteria (generally, a water fountain), whereas after the water jets were installed, water taking increased to 33.81 events per 100 (a 23.70 event increase; $P<.001$). During the same time period, a small but statistically significant increase in water taking was observed at the comparison schools as well (6.62 per 100 preinstallation vs 8.69 per 100 postinstallation; $P<.05$). The net increase in water-taking events in the intervention schools was 21.63 ($P<.001$). Table 4 shows that these results were generally sustained even into the following school year, a 24.61 event increase, for the smaller subset of schools that completed this additional collection. This subset did not differ from the larger group on any demographic characteristics ($P>.05$; results not shown).

Impact on observed milk taking. Table 3 shows that in the first follow-up there was a 7.72-event decrease in milk taking per 100 students at intervention schools, versus a 0.99 event decrease in the comparison schools, for an overall program impact of −6.73 milk taking events per 100 students ($P=.017$). For the subset of schools participating in the longer-term data collection the following school year, impacts on milk taking were not statistically significant at either the first (-3.89; $P=.244$) or second (1.91; $P=.684$) period (Table 4). These findings were robust to 2 sensitivity analyses. The first was to remove schools in which observers reported problems in observing milk taking events (because of large groups of students being away during the lunch period because of field trips, and the cafeteria running out of milk). The second (run separately) was to remove the one school that had an open campus lunch policy. With these changes, the results remained consistent (data not shown).

Impact on Student-Reported Behaviors and Opinions of Water

Of the 2899 student surveys collected, 1759 were from middle or high schools (8th

TABLE 4—Regression Models for Long-Term Follow-Up Results on Water-Drinking and Milk-Taking Events Pre- and Postintervention, by Comparison and Intervention Schools: New York City, 2010–2011

	Comparison Schools				Intervention Schools				Program Impact	
Event	Pre	Post	Change	P	Pre	Post	Change	P	Impact	P
Preintervention period compared with first postintervention period										
Water-drinking events for every 100 students observed, all schools	8.25	11.36	3.12	.003	6.36	28.59	22.23	<.001	19.12	<.001
Milk-taking events for every 100 students observed, all schools	41.99	40.26	−1.74	.432	27.12	21.49	−5.63	.037	−3.89	.244
Preintervention period compared with second postintervention period										
Water-drinking events for every 100 students observed, all schools	10.30	8.14	−2.16	.438	6.87	29.32	22.45	<.001	24.61	<.001
Milk-taking events for every 100 students observed, all schools	58.42	50.22	−8.20	.01	25.32	19.03	−6.29	.036	1.91	.684

Notes. Sample size was n = 12 schools. Analysis from Poisson models in which the dependent variable was the number of water- or milk-taking events, using the number of students in attendance on the day of observation as the denominator. Statistics were rescaled to "100 students observed" by dividing "margins" output by average school attendance, derived either from a simple average, or by dividing the predicted count (from margins) when all independent variables are 0, by the constant term from incidence-rate ratio Poisson output. Models controlled for the percentage of the school that is African American, the percentage of the school that is male, the percentage of the school eligible for free meals and the grade levels that were observed.

and 11th graders) and 1140 from elementary schools (5th graders; Table 5). In the postintervention period, 43.9% of students from the intervention schools reported drinking water at lunch on most days, whereas 32.4% of students in the preintervention period for the intervention schools reported drinking water at lunch on most days. The overall impact was a 9.0 percentage point increase ($P = .043$). The impact was similar in magnitude for elementary school students (9.4 percentage points; $P = .024$) compared with middle- and high-school students (8.2 percentage points; $P = .058$).

The number of self-reported glasses of water drunk the previous day did not change after the introduction of the water jets, staying consistent at 2.3 glasses per day. The impact of water jets was not statistically different for those interviewed on Monday, versus on other school days. We saw no statistically significant decline in the likelihood that students reported drinking milk at lunch on most school days, with percentages for the full sample ranging from 29% to 36%, nor did we see a change in reported number of SSBs or fruit juices consumed the previous day (results not shown). There were no differences between comparison and intervention schools in students' opinions about water before and after water jet installation. In the intervention schools, after water jets were introduced, 55% of students said they liked the taste of tap water, 56% said it was safe to drink, and 53% said the tap was healthy with no change from their opinions before the water jets were introduced.

Overall, 80% said they noticed the water jet in the cafeteria. Middle- and high-school students were significantly more likely to notice it than were elementary-school students (88% vs 62%; $P < .001$). Of those reporting that they noticed it, a series of additional questions were asked. Approximately 64% said they used it "every day" or "occasionally" with no difference between age groups, and 59% liked the taste of the water that came from the machine. The percentage of students who reported liking the taste of the water in the machine was higher for elementary-school students (83%) than for middle- and high-school students (54%; $P < .001$). Approximately 50% of those who noticed the machine indicated that they drank more water as a result of the water jet, and 85% indicated that it was safe to drink water from the machine with no significant differences between elementary-school students and middle- and high-school students (results not shown).

Staff Experiences

In interviews with school cafeteria managers, overall the impression of the water jets was positive. With a few exceptions, water jets were rated as "good" or "great" additions to the cafeterias, and described as popular with students. All managers noted that students were drinking more water since the installation, and most said that more than 50% of students were accessing the water jet. The majority of managers also said that the water jets had no negative impact on students taking milk.

Regarding water jet implementation, opinions were generally positive but more mixed. The kitchen staff spent on average 5 to 15 minutes daily on maintenance (clean and set up the water jet and refill the water and cups as necessary), and 2 managers believed the jets to be too messy such that small children might spill the water and slip.

DISCUSSION

Students whose schools installed water jets almost tripled their water taking at lunchtime

TABLE 5—Regression Models for Student Survey Responses on Water and Milk Consumption, Water Opinion, and Water Jet Opinion Pre- and Postintervention, by Comparison and Intervention Schools: New York City, 2010–2011

	Comparison Schools (n = 9)				Intervention Schools (n = 8)				Program Impact	
Variable	Pre	Post	Change	*P*	Pre	Post	Change	*P*	Impact	*P*
Student drinks water at lunch on most days, %										
All schools (n = 2899)	30.5	33.0	2.5	.37	32.4	43.9	11.5	.001	9.0	.043
Elementary school (n = 1140)	31.6	27.0	–4.6	.024	39.8	44.6	4.8	.207	9.4	.024
Middle and high school (n = 1759)	30.8	37.5	6.7	<.001	27.6	42.5	14.9	<.001	8.2	.058
Average no. of glasses of water drunk the day before survey										
All schools	2.2	2.2	–0.1	.559	2.3	2.3	0.0	.299	–0.1	.286
Elementary school	2.3	2.4	–0.1	.559	2.5	2.4	0.1	.301	–0.1	.287
Middle and high school	2.1	2.1	0.0	.561	2.2	2.2	0.0	.298	0.0	.289
Student drinks milk at lunch on most days, %										
All schools	35.6	33.9	–1.6	.576	35.2	29.2	–5.9	.004	–4.3	.199
Elementary school	42.6	39.8	–2.8	.619	40.4	29.7	–10.7	.061	–7.9	.3
Middle and high school	29.0	29.2	0.2	.947	31.9	28.9	–3.0	<.001	–3.2	.192
Water opinion, %										
In agreement with "I like the taste of tap water"	47.6	59.3	11.7	<.001	47.9	54.7	6.8	.005	–4.9	.173
In agreement with "It is safe to drink water that comes straight from a faucet or tap in New York City"	56.9	55.7	–1.2	.481	53.7	56.4	2.7	.286	3.9	.243
In agreement with "Tap water is healthy"	55.5	52.8	–2.8	.382	50.0	52.9	2.9	.568	5.7	.361

Notes. Sample size was n = 2899 surveys from 17 schools. Models controlled for the gender, race/ethnicity, and grade of the individual student respondent.

relative to what was expected given water taking at baseline and in a group of comparison schools. These results persisted into the following school year. Eighty percent of students in water jet schools noticed the water jets, 65% of those who noticed them used them, and about half of students who noticed the water jets reported drinking more water as a result of their presence, although there was no change in the number of glasses of water students reported drinking the day before the survey (potentially because of limitations in the survey measures, or student substitution behaviors). Water jets were generally well received by cafeteria managers. One potential difficulty in considering expansion is the electrical infrastructure required for water jets. In a school system as old as New York City's, that could be a challenge. However, New York City has made it a goal to put water jets in more than 1000 public schools, and as of mid-2014 more than 800 schools have had the machines installed.[23,24]

Other researchers have examined similar water-drinking interventions in schools, with encouraging results. Patel et al. evaluated the effect of offering chilled, filtered tap water in dispensers similar to water jets in 1 middle-school cafeteria in California, along with a 5-week educational program. The introduction of the water dispensers had a statistically significant positive impact on the likelihood of water consumption.[18] Similarly, in a study by Muckelbauer et al. of the effect of water fountains placed in German elementary schools with a lesson plan and organized daily water bottle fill-ups, compared with children in comparison schools, 2nd- and 3rd-grade students reported drinking more glasses of water per day and were at lower risk of being overweight 1 year after the intervention.[16] Finally Loughridge and Barratt compared the impact of actively promoting water consumption along with improved water access to improving access alone, over a 3-month period in 3 British secondary schools, and found that promoting and increasing water access in schools increased water consumption more than solely increasing water access.[25]

Each of these studies assessed interventions that both promoted improved water access and promoted water through classroom curricula.[16,18] The increase of 0.2 cups per student per day reported here is qualitatively similar to the approximately 0.3 cup increase per student per day in the study by Patel et al.; however, unlike their study, the intervention studied here had no educational or behavioral components accompanying the increase in water availability. In light of Loughridge and Barratt's results, it is possible the effect we observed on water consumption would have been larger had New York City's schools also promoted water consumption. Promotion might also increase water intake outside school, which we did not observe. Future research efforts may further elaborate the separate effects of increasing water access and promoting water consumption inside and outside the school environment.

We also found that the introduction of water jets had a small impact on observed milk taking, which may have subsided by 1 year after baseline, a pattern similar to the introduction of low-fat milk in New York City's public schools. However, our ability to definitively claim that the impact on milk taking was eliminated within a year of baseline is limited by the low sample size and statistical power of the second follow-up wave.[26] Self-reported milk intake was unaffected.[26] Our findings suggest that there was no change in the students' opinions about water overall. Most students had the perception that the water coming from the machine was safe to drink.

Limitations

This study has several limitations. First, although the observation-based design provides an objective measure of water and milk taking, we were not able to observe actual consumption of the water or milk taken by students or to observe potential water consumption outside the cafeteria area. Related, we were also not able to observe the exact number of children in the cafeteria and to use attendance on the day of observation as a proxy. Second, although every effort was made to minimize the differences between treatment and comparison schools through sample selection, and to minimize the impact of any residual differences through statistical adjustment, we are unable to rule out the possibility that some portion of our estimated impacts may be attributable to confounding. With the size of our main impact, however, we are reasonably confident that water jets significantly affected water taking. Third, student self-report data come from only a subset of participating schools and are subject to recall bias, and consumption measures face inherent measurement problems. Fourth, New York City has a policy of no SSBs or other competitive foods in their public schools, which may limit the generalizability of our results. Fifth, the longer-term follow-up data only come from a nonrandomly selected subset of schools and may not reflect what happened at all schools. However, no differences in demographic characteristics were apparent between the schools that participated in the long-term follow-up and those that declined. Finally, it is not known whether the same impacts would have been found with other new, accessible sources of water (such as water jugs or stations) instead of water jets.

Conclusions

We found that the implementation of a relatively simple and straightforward school-based intervention—the provision of water jets in school cafeterias at lunchtime—significantly increased observed student water taking, and this effect persisted over time, even with no promotional campaign. Although there was an initial decrease in the taking of milk for consumption, it was disproportionately small compared with the accompanying increases in taking of water for consumption and the effect appeared to diminish over time. Schools may be able to further enhance results by conducting accompanying promotional campaigns or implementing other methods of increasing awareness of the water jets. ■

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Contributors

B. Elbel and T. Mijanovich conceptualized the study, design, and analysis plan, and contributed to interpretation of results and writing. L. Dunn, C. Nonas, and K. Cappola contributed to the design of the study, were

responsible for data collection and entry, and were involved with interpretation of results, editing, and writing. C. Abrams and J. Cantor contributed to the analysis, interpretation of results, and writing. S. Onufrak and S. Park contributed to the design of the study, interpretation of results, and editing.

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Human Participant Protection

The study received approval from the institutional review boards of the New York City Department of Health and Mental Hygiene, the New York City Department of Education, and the New York University School of Medicine. The principals at the participating schools signed informed consent forms, and letters were sent to parents and guardians of all students enrolled at the participating schools explaining the study's design and methods and including contact information for the Department of Health and Mental Hygiene study coordinator in case any parents had questions or wanted to withdraw their children from the study.

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