



Drinking water access in California schools: Room for improvement following implementation of school water policies

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ABSTRACT

This study aims to investigate how access to free drinking water in California public schools changed after implementation of 2010 federal and state school water policies.

Repeated cross-sectional surveys were conducted with administrators in a random sample of California public schools, stratified by school type and urban-centric geography, from 2010 to 2011 ($n = 240$) and from 2016 to 2018 ($n = 240$). Surveys assessed excellence in drinking water access, defined as 1) providing water in 4 of 5 key school locations, 2) having a high density of free water available, 3) providing water via a non-fountain source, 4) providing water that is perceived as safe, and 5) offering water sources that are reported as clean and functioning. Multivariate logistic regression was used to examine changes in excellence in drinking water access after implementation of school drinking water policies. Analysis was completed in 2019.

In 2010–2011, 5% of schools met all water excellence criteria; in 2016–2018, 18% of schools met all excellence criteria. In adjusted models, post-legislation schools had 4 times the odds of meeting all drinking water excellence criteria compared to pre-legislation schools (OR: 4.34; 95% confidence interval = 2.07, 9.10).

There were significant increases in public schools meeting the criteria for excellence in free drinking water access after school water policies were implemented; however, a majority of schools still lacked excellent water access. Findings suggest that policies mandating free water access in schools may help to improve excellence in access, and more work is needed to help all schools excel in this area.

1. Introduction

Drinking water instead of sugar-sweetened beverages (SSBs) can help prevent obesity, type 2 diabetes, and dental caries, and improve cognitive function (Wang et al., 2009; Popkin et al., 2010; Ebbeling et al., 2006; Edmonds and Burford, 2009; Edmonds and Jeffes, 2009; Daniels and Popkin, 2010; McDonagh et al., 2000; Muckelbauer et al., 2009; de Ruyter et al., 2012; Schulze et al., 2004; Malik et al., 2006). Many students, who spend the majority of their day in school, arrive at school inadequately hydrated (Kenney et al., 2015). Thus promoting intake of drinking water in schools is critical to health (Kenney et al., 2015).

In September 2010, California enacted Senate Bill (SB) 1413, which required California public schools to provide free drinking water in food service areas or locations where meals are served and/or eaten by July 2011 (California Senate Bill No. 1413, 2010). This legislation prompted comparable language to be included in the 2010 federal Healthy, Hunger-Free Kids Act (HHFKA), with 3-year administrative reviews to ensure school compliance (Healthy, Hunger-Free Kids Act of 2010, 2010).

Although these laws require free drinking water in food service areas, they do not mandate that water be provided in ways that maximally encourage consumption. Factors, herein termed water excellence criteria, can help promote water intake in schools, including 1)

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offering water sources such as water bottle filling stations that are more functional and appealing than drinking fountains (Patel et al., 2016), 2) ensuring a high-density of water access (Onufrak et al., 2014), 3) providing safe and appealing water, 4) ensuring that water sources are clean, and functioning (Patel et al., 2014), and 5) providing cups or reusable bottles to increase the quantity of water consumed (Kenney et al., 2015).

While a few studies have examined drinking water access in schools post-implementation of water policies (Hood et al., 2014; Bogart et al., 2016), no studies have comprehensively examined how factors that promote water intake in schools have changed following policy implementation. This study's objective is to document how excellence in free drinking water access in California schools changed after implementation of California SB 1413 and HHFKA. We hypothesized that there would be an increase in excellence in free drinking water access in schools after implementation of the policies.

2. Methods

2.1. Design

This study employed a repeated cross-sectional design. From May to November 2011 (pre-policy implementation), researchers conducted semi-structured telephone interviews with school administrators from a random sample of 240 California public schools. Repeat surveys were completed with a separate random sample of 240 California public schools from March 2016 to August 2018 (post-policy implementation). Eligible schools were selected from the National Center for Education Statistics' *Common Core of Data* (2009). Schools with less common grade configurations (kindergarten to 8th grade, kindergarten to 12th grade), and special education, vocational, and alternative schools were excluded. Eligible schools were stratified by geography (i.e., rural, town, suburban, city) and school type (i.e., elementary, middle/junior, high), and schools were randomly selected from these study frames. In 2010, a total sample of 10,152 schools were eligible; in 2016, 10,481 schools were eligible. This study was approved by the Committee on Human Research at the University of California, San Francisco and the Institutional Review Board at Stanford University.

2.2. Interview instrument

The interview questionnaire was developed based on previous studies of drinking water access in schools and revised by the study team and other content area experts to ensure that the interview questions could accurately capture the proposed research questions (Patel et al., 2014). The tool was pilot-tested with ineligible schools (private or out-of-state schools) to avoid contaminating the study sampling frame (Patel et al., 2010; Patel et al., 2011; Patel et al., 2012). The revised questionnaire was validated through in-person observations and the results of that study and the study instrument are published elsewhere. Questions related to the availability, type, and location of free water sources all had kappa values that indicated substantial or almost perfect agreement (Patel et al., 2012; Hecht et al., 2017). The same questions about excellence in water access were used in both 2010–2011 and 2016–2018 study waves. During the 2016–2018 surveys, respondents were asked additional questions about student water bottle usage in the classroom, drinking water quality testing, and their knowledge of the water-in-schools policies that passed after the initial round of surveys were conducted.

2.3. School recruitment

To recruit schools, the study team mailed a study invitation letter to the principals of sampled schools. Then, a research assistant or the principal investigator contacted school administrators to assess their interest in participating and to schedule a time to complete the

interview. Schools were contacted until they declined to participate, at which point the study team randomly sampled the next school from that stratum. Consent was obtained from each respondent before completing the interview. Interviews were conducted over the phone and lasted approximately 20 minutes. In 2010–2011, study participants were given \$10 gift cards for participation; in 2016–2018, respondents were given \$15 gift cards.

2.4. Outcome measures

Respondents were asked about all of the school's drinking water sources in order to obtain a comprehensive assessment of excellence in water access beyond the food service area policy requirements. Specifically, surveys examined the total number of water sources, the type of water used (e.g., tap, bottled), delivery method (e.g., fountains, pitchers, hydration stations), location (e.g., cafeteria, gym, classrooms), and if schools provided any drinking vessels (e.g., cups or reusable water bottles) for students near the water sources. Study participants were also asked about the overall appeal, function, cleanliness, and safety of drinking water sources. Finally, respondents were asked to report on barriers and facilitators to providing students access to water, their knowledge of school water policies, and any changes that their school made to their drinking water access in the last five years.

The main outcome, excellence in drinking water, was defined as, "water availability throughout school settings that most facilitates water consumption among students." (Patel et al., 2014) Specifically, schools were considered to have excellent free drinking water access if they met all of the following criteria:

1. provide water in at least 4 of 5 key school locations (food service areas, classrooms, indoor and outdoor physical activity spaces, high-traffic common areas)
2. have a high density of free water available (i.e., ≥ 1 water source for every 25 students)
3. provide water via a non-fountain source that encourages increased water intake (e.g., pitcher, water dispenser, hydration station) in at least one location
4. provide tap water that is perceived as safe and appealing (i.e., palatable, safe to drink, cold)
5. offer water sources that are perceived as clean and functioning

Data on school-level characteristics were obtained from the Education Data Partnership (*Fiscal, demographic, and performance data on California's K-12 schools*, 2009).

Characteristics included school type (e.g., elementary, middle/junior, high), geography (e.g., city, suburb, town, rural), student enrollment, school Academic Performance Index (API) score based on student testing results, the percentage of English learners, racial/ethnic makeup of the school, and the percentage of students eligible for free or reduced-price meals (proxy for low household income).

2.5. Statistical analyses

Data were double-entered into Research Electronic Data Capture (REDCap), checked for any errors in data entry, and analyzed using Stata version 15 (StataCorp LP, College Station, TX). Descriptive analyses (e.g., frequencies, percentages, means) were used to summarize school-level characteristics and main outcomes. Multivariate logistic regression was used to examine changes in the proportion of schools meeting excellence in free drinking water access after the water-in-schools policies were implemented. Analyses were conducted in 2019.

3. Results

Of schools in the 2010–2011 wave that were eligible for and contacted about this study, 93% agreed to participate. The response rate

Table 1
Characteristics of All California Public Schools and Participating Study Schools: 2010–2011 and 2016–2018.

Characteristic	California Public Schools: 2011 (n = 10,152)	California Public Schools: 2017 (n = 10,481)	Participating Schools: 2010–2011 (n = 240)	Participating Schools: 2016–2018 (n = 240)	P value ^a
Student enrollment, mean					
Elementary	530	525	536	494	0.223
Middle/Junior High	806	758	808	622	0.004
High	1404	1326	1343	1269	0.610
Academic Performance Index, mean	768	790	776	786	0.136
Free/reduced price eligible, %	55	58	53	63	< 0.001
English learners, %	22	21	20	20	0.887
Latino students, %	51	53	46	52	0.027
Respondent type, %	n/a	n/a			
Principal	–	–	58	47	0.014
Vice Principal	–	–	22	15	0.048
Facilities	–	–	7	7	1.000
Other	–	–	13	31	< 0.001
Response rate, %	n/a	n/a	93	86	0.013

^a P values comparing differences in school characteristics between study waves were calculated using t-tests and chi-squared tests.

was lower (85%) in the 2016–2018 study wave (Table 1), though schools that participated in the study had similar characteristics as compared with California public schools overall. There were some significant differences in school-level characteristics between the 2010–2011 to 2016–2018 waves, including a decrease in middle school enrollment, an increase in students eligible for free/reduced priced meals, an increase in Latino students, and a decrease in principal and vice principal respondents (Table 1).

After implementation of state and federal policies that required free water in food service areas, there was a 13% increase in the percentage of schools meeting all drinking water access excellence criteria (5% vs. 18%; $p < 0.001$). After adjustment for school characteristics (i.e., school type, geography, enrollment, API score, English learners, Latino students, and students eligible for free or reduced priced meals), post-legislation schools had over four times the odds of meeting all drinking water excellence criteria (odds ratio [OR] = 4.34 95% confidence interval [CI] = 2.07, 9.10) (Table 2).

After implementation of CA SB 1413 and HHFKA, the percentage of schools offering at least one free drinking water source in high traffic areas of the school increased, with significant increases noted in food service areas, outdoor physical activity areas, classrooms, and temporary structures used to accommodate additional students (Table 2).

After the implementation of SB 1413 and HHFKA, there was also a significant increase in the percentage of schools offering not only fountain, but also non-fountain water sources such as individual bottles and pitchers, water dispensers, and hydration stations. In adjusted models, post-legislation schools had nearly 14 times the odds of offering water through pitchers, dispensers, or water stations (OR = 13.92; 95% CI = 7.48, 25.90) as compared to pre-legislation schools. The mean density of water sources in schools also significantly improved from 2010 to 2011 to 2016–2018 (1 water source per 25 students to 1 water source per 16 students; $p < 0.001$) (Table 2).

Although not considered one of the five major criteria for excellence in drinking water access, the proportion of schools offering drinking vessels, such as cups or reusable water bottles, also increased from pre- to post-implementation of water policies (18% in 2010–2011 to 65% in 2016–2018) (Table 2). Of those schools that offered drinking vessels in the second study wave, the majority (65%) offered them in easily accessible locations, such as food service areas. Ninety-six percent of respondents surveyed in 2016–2018 said that students were allowed to use water bottles in school.

Post-legislation, there was no change in the percentage of respondents reporting that their drinking water sources were safe and appealing, or that their water sources were clean and functioning (Table 2).

In 2016–2018, approximately half (49%) of respondents stated that

they were aware of federal/state laws that require free water at meal-times. Respondent awareness of SB 1413 and HHFKA was associated with having water available in school food service areas; among those that were aware of these policies, 95% of their schools offered free water in food service areas, compared with 80% among schools that were not aware of these policies ($p = 0.001$). Respondents' recommendations for educating schools about the water mandates included emailing, calling, and scheduling in-person meetings, particularly with superintendents and directors of facilities and nutrition services, who could relay information to on-the-ground staff in schools. Most administrators were not aware of other school-level policies relating to drinking water access (e.g., in their school accountability report card, master facilities plan, or school district wellness policy). Nineteen percent of respondents reported that water was mentioned in their school accountability report card (school report with information about the condition and performance of the school); 17% reported that water was mentioned in their master facilities plan; and 19% reported that water was noted in their school district wellness policies. About half of respondents (53%) reported making changes to water access at their school in the last five years. When asked qualitatively about barriers to providing access to free drinking water to students, respondents overwhelmingly responded that funding was the major barrier to increasing access. With increased funding, the majority of schools reported that they would purchase hydration stations, refrigerated water fountains, and reusable water bottles for students, but currently lack the funding to do so.

4. Discussion

In this study, there were significant increases in the percentage of schools that met all excellence criteria for drinking water access. However, given that only approximately 1 in 5 schools met all water excellence criteria, more work is needed to ensure that schools excel in providing drinking water that promotes water intake and improves student health.

Given that one in two students is inadequately hydrated at school (Kenney et al., 2015), it is important that drinking water is available not only in cafeterias, where law requires access, but also in other locations throughout the school campus. Notably, all sampled schools in 2010–2011 and 2016–2018 offered free water in at least one location throughout the school (Patel et al., 2014). While we hypothesized that there would be improvements in free water access in food service areas as mandated by school water policies, in this study we found increases in drinking water access in other high-traffic areas of the school as well, such as outdoor physical activity areas, classrooms, and temporary structures. These improvements in water access in locations throughout

Table 2
Excellence in water access in California public schools before (2010–2011) and after (2016–2018) implementation of school water policies.

Indicator of Excellence in Water Access	2010–2011 (n = 240) %	2016–2018 (n = 240) %	Unadjusted P value	Adjusted Odds Ratio (95% CI) ^a
Overall Excellence ^b	5	18	< 0.001	4.34 (2.07, 9.10)
Water in 4 of 5 Key Locations ^b	65	81	< 0.001	2.69 (1.67, 4.34)
Food service area	75	87	0.001	2.23 (1.32, 3.76)
Indoor physical activity	83	87	0.295	1.58 (0.79, 3.16)
Outdoor physical activity	80	91	< 0.001	3.08 (1.65, 5.76)
Classrooms	63	83	< 0.001	3.52 (1.99, 6.22)
High-traffic common areas	95	94	0.662	0.65 (0.27, 1.57)
Temporary structures	38	52	0.008	1.77 (1.05, 2.96)
Non-fountain water sources ^b	22	65	< 0.001	7.17 (4.49, 11.45)
Individual bottled water	3	19	< 0.001	7.59 (3.18, 18.13)
Large bottled water	13	18	0.131	1.14 (0.64, 2.01)
Pitchers, dispensers, hydration stations	9	50	< 0.001	13.92 (7.48, 25.90)
Appealing fountain water sources				
Refrigerated fountain	17	38	< 0.001	2.81 (1.72, 4.57)
Filtered fountain	18	41	< 0.001	2.93 (1.84, 4.66)
Refrigerated & filtered fountain	3	20	< 0.001	9.12 (3.76, 22.12)
Less appealing fountain water sources				
Unrefrigerated, unfiltered fountain	96	80	< 0.001	0.22 (0.10, 0.46)
Fountain to student ratio				
Overall ratio (mean)	0.04	0.06	< 0.001	–
1 per 25 students ^b	43	59	< 0.001	2.49 (1.49, 4.14)
1 per 50 students	64	73	0.039	1.85 (1.05, 3.25)
1 per 100 students	85	89	0.175	1.69 (0.81, 3.50)
1 per 150 students	94	96	0.308	1.85 (0.69, 4.98)
Safe and appealing ^b	60	63	0.512	1.33 (0.88, 2.01)
Clean and functioning ^b	83	84	0.624	1.07 (0.63, 1.80)
Exemplary water access				
Drinking vessels ^c	18	65	< 0.001	7.94 (4.99, 12.63)

^a Models adjusted for school type (elementary, middle/junior, high), geography (rural, town, suburb, city), enrollment, API score, % English learners, % Latino students, % eligible for free or reduced priced meals.

^b Indicators are components of the overall excellence variable.

^c Vessels include cups or reusable water bottles.

the school are promising. However, given that 13% of schools still did not have free water available in the food service areas, work is needed to help all schools comply with existing school water policies.

This study also demonstrated significant improvements in the density of water sources in schools. State plumbing codes, a subset of building codes that set standards for the minimum number of water sources required per individual in buildings, vary greatly by state, ranging from 1:30 to 1:150, with the most common plumbing code requiring 1 water source for every 100 students (Onufrak et al., 2014). In a national study, youth reported greater accessibility to drinking fountains in states with higher density plumbing codes (Onufrak et al., 2014). In this study, we found that almost all schools met the California state plumbing code standard of offering 1 water source for every 150 students. We also found significant improvements in the density of water sources in schools from pre- to post-water policy implementation, with 59% of schools meeting the stringent standard we defined, of offering 1 water source per 25 students. Although providing a higher density of water sources in schools may help promote water intake among students, installing additional water sources may overwhelm school maintenance and drinking water testing requirements. Future studies should examine the ideal plumbing code that is cost-effective in promoting water intake.

Over time, there were also increases in access to non-fountain water sources, such as water stations, pitchers, and bottled water, that may be more functional and appealing than traditional drinking fountains. After HHFKA was passed, the United States Department of Agriculture (USDA) released a memo suggesting innovative ways to increase access to water in food service areas such as providing pitchers or installing water bottle filling sinks or stations (Child Nutrition Reauthorization, 2010). In the present study and in others, drinking fountains are still the most common source of drinking water in schools (Hood et al., 2014; Patel et al., 2012; Patel and Hampton, 2011). Since studies suggest that non-fountain water sources may more effectively encourage water

consumption in schools (Kenney et al., 2015; Patel et al., 2011; Patel et al., 2012; Patel and Hampton, 2011), it is important to encourage their uptake. Increases in non-fountain water sources seen in the present study may have been due to water-in-schools policies, industry trends, water campaigns, or guidance from USDA, state Departments of Education, or school districts that are reaching relevant school staff in a significant share of schools. Introducing a policy requirement and funding opportunities to install bottle filling stations or other non-fountain water sources, or requiring installation of bottle filling stations rather than traditional drinking fountains in new school construction, may help further augment increases in appealing water sources that were observed in the present study. Retrofitting existing fountains with a bottle-filler spout offers a lower-cost method of achieving that goal.

In this study, there was also an increase in the percentage of schools providing drinking water vessels to students, including cups and reusable water bottles. This is important because providing small cups next to water sources can help increase the amount of water that students are consuming (Kenney et al., 2015). While recyclable or compostable cups can decrease the environmental footprint of this water promotion method, future efforts should encourage reusable water bottle use in schools. Since 95% of schools reported that students are allowed to use reusable water bottles in the classroom, providing water bottles to students or listing them on back-to-school supply lists may help to build a culture of reusable water bottle use in schools.

Despite promising improvements in drinking water access in schools, it is also critical that schools offer safe drinking water and ensure that water sources are functioning and well maintained. In this study, we saw a need for improvements in these areas. Neither CA SB 1413 or HHFKA mandate strict standards for water quality (California Senate Bill No. 1413, 2010; Healthy, Hunger-Free Kids Act of 2010, 2010), and there is limited funding for capital infrastructure investments and remediation of contaminants in drinking water. However, in 2017, California implemented AB 746, a mandatory requirement for public water systems to

test water in schools for lead, and the state also established a \$9.5 million Drinking Water for Schools grant program (California Assembly Bill No. 746, 2017; California Senate Bill No. 828, 2016). While this is an important first step, it is critical that schools test drinking water for a greater variety of contaminants as needed and expand water policies to regulate ongoing maintenance of clean and safe water sources in schools once the initial wave of testing is complete.

Although policies requiring free drinking water at mealtimes passed in 2010, only about half of study respondents were aware of these mandates. As respondents' awareness of these mandates was associated with policy compliance, it may be important to educate schools about existing and future policies using the methods recommended by the respondents, such as emailing, calling, and scheduling in-person meetings with administrators who could relay information to on-the-ground staff in schools. Since funding was a primary barrier to improving water access, pairing policy requirements with funding resources could aid implementation efforts.

4.1. Limitations

This study does have several limitations. Although the study was conducted in California, a large, populous, and racially/ethnically and socioeconomically diverse state, findings may not be generalizable to other areas. As California has pioneered water-in-schools policies and practices, improvements in drinking water access and quality observed may be due to secular trends or other factors beyond the legislation not captured in this study. An ideal study design would use a control group in another location that did not have drinking water policies. However, given that the policies affected all schools in the United States, this was not possible. While this study employed a validated survey, the survey relied on respondents' perceptions and memories, and thus direct observations of water access in schools may reveal less favorable conditions. Some of the baseline surveys (32%) were conducted after SB 1413's implementation date. However, there was a marginal increase in water available in food service areas among baseline schools after implementation in 2011 ($p = 0.048$), and no change in schools offering nonfountain water sources ($p = 0.45$) (Patel et al., 2014). Although the schools in 2010–2011 and 2016–2018 study waves have some demographic differences, our analyses controlled for these characteristics.

5. Conclusions

Given the poor health outcomes associated with consumption of SSBs, it is important to ensure that children have access to drinking water as a healthy alternative. Despite significant improvements to free water access in California schools after implementation of SB1413 and HHFKA, there are still gaps in excellent drinking water access in schools. Creating school environments that maximally promote water intake for students' overall health and well-being will not only require expansion of drinking water policies and funding, but the dissemination of new requirements and opportunities to key school stakeholders.

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Credit authorship contribution statement

Emily A. Altman: Investigation, Data curation, Writing - original draft. **Kevin L. Lee:** Conceptualization, Methodology, Writing - review & editing. **Christina A. Hecht:** Conceptualization, Methodology, Writing - review & editing. **Karla E. Hampton:** Conceptualization, Methodology, Writing - review & editing. **Gala Moreno:** Investigation, Data curation, Writing - review & editing. **Anisha I. Patel:** Conceptualization, Methodology, Investigation, Writing - review & editing, Supervision.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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