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A randomized trial of a multi-level intervention to increase water access and appeal in community recreation centers

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ABSTRACT

Introduction: Improving children's tap water intake and reducing sugar-sweetened beverage (SSB) consumption is beneficial for health and health equity, particularly in low-income communities and communities of color. Existing community level interventions to improve the intake of tap water have predominantly occurred in schools and have focused on promoting water consumption in cafeterias during lunch or snack periods.
Methods: The "Hydrate Philly" intervention was developed to target multiple environmental and social factors to improve tap water consumption in community recreation centers in low-income communities: replacing old and unappealing water fountains with appealing water-bottle-filling "hydration stations", conducting water safety testing and publicizing results, disseminating reusable water bottles, promoting tap water, and discouraging SSB consumption. Efficacy of the intervention will be tested through a group-randomized controlled trial (n = 28 centers) of the intervention's impact on center-level water fountain/station use as measured by flow meters during a youth summer camp program primarily for children aged 6–12 years. Intervention impact on the primary outcome (use of drinking water sources) will be examined with a difference-in-differences approach using an ordinary least squares regression model for analysis at the center level. Secondary outcomes include SSBs brought to summer camp, reusable and single-use bottled water use, program trash, and recreation center staff SSB consumption.
Discussion: Multilevel approaches are needed to increase tap water intake and decrease SSB consumption among low-income and minority youth beyond school and meal settings. The current study describes the Hydrate Philly intervention, the study design, and baseline characteristics of recreation centers participating in the study.
ClinicalTrials.gov Registration: #NCT03637465

1. Introduction

Improving children's tap water intake and reducing their sugar-sweetened beverage (SSB) consumption is beneficial for health [1–3] and health equity [4,5], particularly in low-income communities and communities of color [6,7]. Children's oral health, cognitive performance, and risk for obesity and kidney stones can benefit from increased water intake and reduced SSB consumption [1–3].

Children may technically have access to water at schools or community recreation centers as it is often required by federal food programs and/or local regulations [8]. However, the water fountains may be old, obstructed by items, have insufficient flow, provide warm water, or appear unclean [9,10], which could serve to discourage tap water consumption. Even if the water source is appealing, there may still be concerns about the safety of tap water. Improving access to safe and appealing tap water could provide an attractive cost-effective policy target, [11] especially in youth at high-risk for chronic disease.

Existing interventions to improve the intake of tap water by installing appealing reusable water bottle filling "hydration stations" have predominantly occurred in schools and have focused on promoting water consumption in cafeterias during lunch or snack periods [12–14]. Community recreation centers offer a variety of after-school,

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summer camp, and other out-of-school and community programming and are important resources that may also benefit from improved water access and appeal. This is particularly important in low-income neighborhoods where corner stores are common and sell predominantly unhealthy foods and beverages [6]. Yet another potential benefit of tap water promotion in community settings is the possible reduction of trash from single-use plastic water bottles.

Therefore, the aims of the current cluster randomized controlled trial (RCT) are to determine the effectiveness of the "Hydrate Philly" multi-level intervention to increase water access and appeal in community recreation centers in (1) increasing center-level water intake as measured by water flow meters, and (2) decreasing the purchase of outside beverages as measured by observations of youth visiting recreation centers. Secondary outcomes include use of single-use and reusable bottles and recreation center staff SSB consumption. The goals of the current paper are to describe (1) the Hydrate Philly intervention development and implementation, and (2) the study design and baseline site characteristics.

2. Methods

2.1. Study design and timeline

This study is a pragmatic cluster randomized controlled trial (RCT) testing the efficacy of a multifaceted intervention to improve water access and appeal in 29 community recreation centers (14 matched pairs plus 1 pilot site). Eligibility criteria for center participation included (1) location in a low-income neighborhood as defined by having 20% or more of the residents in the center's zip code at or below 100% of the federal poverty level, consistent with the federal definition of concentrated poverty, (2) willingness to comply with the City of Philadelphia Healthy Vending Standards and to encourage youth not to bring in outside food and SSBs to centers, (3) water lines that are accessible and appropriate for installing hydration stations inside the facility, (4) willingness to agree to the randomization procedure, (5) site has both summer and after-school programming and (6) site has a potential matched site as described below.

All 151 recreation centers in the City of Philadelphia were assessed for eligibility. Eligible recreation centers were matched on key characteristics, listed in order of prioritization for matching: (1) types of facilities and programming offered (e.g., indoor versus outdoor, sports leagues participation, pool and outdoor fields), (2) size of the facility and out-of-school time programs, and (3) demographics of the surrounding census tracts of centers, including percent of residents that are minority (i.e., non-white) and percent of residents below 100% federal poverty level.

After applying these criteria 36 centers were eligible to participate, and all of these sites had appropriate matches. To maximize fairness and generalizability, 29 centers were randomly selected to participate using a random number generator, and the pilot site was selected based on logistical considerations, willingness of center staff to assist with intervention development, and high center traffic. For the remaining 28 centers, 14 matched pairs were created and one center in each matched pair was randomized to receive the intervention through a coin flip. The coin flip was conducted at a kickoff party in front of all participating sites to facilitate transparency. At the time sites were enrolled, the study design included a no treatment control. However, at a later date the Philadelphia Parks and Recreation Department (PPR) committed to providing all control sites with a hydration station upon completion of the study.

Three measurement periods, each lasting 2 weeks, occurred: baseline (July/Aug 2017), mid-point (March 2018), and post intervention (July/Aug 2018). This timeline allowed PPR staff to complete installation of hydration stations during the time of year (Sept-Dec) with the greatest staffing flexibility and ensured the intervention was ready for implementation during PPR's peak summer season. Mid-point and post-intervention measures occurred approximately 3–5 months and 7–9 months, respectively, after hydration stations were installed depending on installation timing. The study timeline was developed to meet the needs of PPR to avoid interference with the summer pool season, as recreation center pools require the same installation team as the current project and create a high work burden for PPR. The Philadelphia Department of Public Health Institutional Review Board approved the study. All research protocols and forms are available on ClinicalTrials.gov (#NCT03637465).

2.2. Target population, sample, and sample setting

PPR serves over two million meals and snacks to children annually through after-school, summer, and sports programs across the city and has approximately 700 permanent and 2300 seasonal staff in 151 centers, emphasizing the need for access to appealing water. PPR programming targets children between the ages of 6–12 years but may also include minimal programming with adolescents, children aged 3–5 years in select sites, and adults. Access to water is required for federally reimbursable meals, and although it is available the water may not be chilled or may be from outdated fountains that do not encourage consumption. Other barriers to water access include long lines for fountains or that children have to specifically request water to receive it. Administrative data of demographic characteristics from all youth enrolled in PPR out-of-school time programs (including both summer camp and after-school programs) were obtained for sites participating in Hydrate Philly (Table 2).

2.3. The hydrate philly intervention

2.3.1. Theoretical framework

The "Hydrate Philly" intervention was based on two health behavior theories. The social ecological model [15] emphasizes multiple interacting levels of influence on behavior including environmental, policy, and macro-level influences on health as well as individual and social factors. Social cognitive theory [16] emphasizes changing perceived barriers and facilitators, improving efficacy, and changing social systems to change behavior. In particular, environmental access, perceptions of the environment, and sociocultural norms (from the social ecological model) will be targeted through water infrastructure changes and summer camp promotional activities, which support removing barriers, increasing facilitators, and garnering broader social support for increasing water consumption and decreasing SSB consumption. The components, strategies, and theoretical constructs of the Hydrate Philly multi-level intervention are shown in Table 1.

2.3.2. Hydration station installation

To determine where hydration stations would be installed, a comprehensive needs assessment was conducted that included evaluating center size, level of center foot traffic, conditions of existing water fountains, plumbing infrastructure, and site preferences. These factors and, in particular, plumbing infrastructure and installation feasibility, helped influence the locations where the hydration stations would be installed. Following the installation of 2 hydration stations at the pilot site, PPR staff installed 20 hydration stations (Elkay model #EEZS8WSSK) over the course of approximately 3 months at the 14 intervention sites (ranging from 1 to 2 per site). The units were stainless steel, included a bottle filler and a bubbler (i.e., traditional spigot for drinking), and did not include water filters due to the high quality of local tap water and desire to reduce long-term maintenance costs. Outdoor hydration stations were not considered for the current study as they require additional maintenance (i.e., winterization) and vandalism protection that were beyond the scope of the study.

2.3.3. Water quality testing

Although there were no concerns about the safety of drinking water

Table 1
Components, targeted strategies, theorectical constructs, and theories of the Hydrate Philly intervention.

Intervention component	Targeted strategies	Theoretical constructs	Health behavior change theory
Hydration station installation	• Replace existing old water fountains with hydration stations	Environmental access	SM
	• Increase density of water sources by installing new water lines and hydration stations	Perceptions, Reduced barriers	SM, SCT
	• Improve fountain appeal and cleanliness		
Water safety testing	• Test water for quality and safety	Perceptions, Reduced barriers	SM, SCT
	• Communicate test results	Social norms, Cultural norms	SCT, SM
	• Facilitate transparency of testing procedures and results		
Reusable water bottles	• Increase access to water through provision of reusable water bottles	Environmental access	SM
	• Improve program norms around carrying water bottles	Social norms	SCT
Promotional campaign	• Emphasize benefits of water and downsides of SSBs	Social and Organizational norms	SCT, SM
	• Promote availability of new hydration stations		
	• Encourage parents to send only water with children to recreation center		
	• Encourage consumption through gamified group-based goal setting		
Decreased access to unhealthy foods and beverages	• Reduce environmental access through discouraging outside SSBs at recreation centers	Environmental access	SM
	• Change organizational norms around acceptance of unhealthy outside foods/SSBs at recreation centers	Organizational norms	SM

Notes: SCT = Social Cognitive Theory; SM = Socialecological Model.

in the recreation centers slated to receive the water intervention (or more broadly), partners agreed that testing center drinking water for lead, as recommended by the EPA, as well as other contaminants was essential to overcome the negative community perceptions of tap water. Water quality testing included testing for the absence of water contaminants (total coliform bacteria, *E. coli* bacteria, arsenic, barium, cadmium, chromium, lead, nickel, and mercury) as well as other indicators of quality (pH, chlorine residual, turbidity, heterotrophic bacteria, total dissolved solids) and constituents that may affect the taste of the water from new plumbing fixtures (copper and zinc). As recommended by water quality testing experts at the local water department, water testing was conducted at each water outlet that received a new hydration station approximately 2 to 3 weeks after the unit was installed. This time period allowed for passivation, or the conditioning of the new plumbing materials that are in contact with water, wherein residual elements that can affect taste but not health dissipate over time as the plumbing materials are used (sometimes referred to as a "new car smell" for water units). Two first draw samples (first thing in the morning prior to any water use at the facility) and a flushed draw sample [17] were provided to the lab within 24 h of sampling. Safe lead levels were set to be below 10 ppb, which is below the EPA action standards of 15 ppb for public water sources [36]. Due to a mistake on the lab test selection forms, only the flushed samples were tested for lead. To facilitate transparency, at sites where staff were concerned about water quality, water sampling was conducted with recreation center staff present. Testing and sharing of results were conducted in accordance with the EPA's 3 T's: Train, Test, Tell [18]. Specifically, each site was sent a plain language letter detailing the tests that were conducted and their results.

2.3.4. Reusable water bottle distribution

Although some research has shown that cups placed next to water dispensers increased water consumption in schools [12], the provision of disposable cups can lead to added costs for maintenance, trash, and janitorial services. Therefore, to maximize the suitability of the intervention for broad dissemination, reusable water bottles were chosen over cups to promote water intake. Recreation center staff distributed a 28-ounce, Bisphenol A (BPA)-free plastic Hydrate Philly branded reusable water bottle to each summer program student and some staff at all intervention sites. To maximize scalability and to reflect real-world practices at PPR centers, sites could decide how they wanted to distribute and track water bottles. Some sites elected to have youth keep water bottles on site for the duration of the summer camp and others elected to send the water bottles home with youth. Variability in site decisions around implementation were tracked in fidelity assessments (described below).

2.3.5. Water promotion campaign

A campaign to promote the acceptability of tap water, including brief training for recreation center staff, a game the sites could use to encourage water consumption during out-of-school programming, and parent handouts, was implemented at intervention sites. Site leaders voted on the preferred name of the intervention campaign at the kickoff event to encourage ownership of the campaign. The training included behavioral and social strategies for staff to discourage SSB consumption and encourage water consumption, including how to publicize hydration stations to parents and youth, how to discourage SSB intake on premises, ways to reinforce the positive results of water quality testing, and ideas for encouraging tap water consumption during the program. Site leaders for 10 of 14 sites attended the training and supplementary individual trainings were provided to those who were absent. A "weekly water challenge" game was developed to facilitate a group-based goal for each student to drink the recommended amount of water for their age. At intervention sites, a large poster of a pool was posted. Children were asked to place a water drop sticker to symbolize filling the pool with water when they drank water. Recommended amounts of water intake were adjusted for children's age groups and represented in terms of the number of 28-oz reusable program water bottles (see Appendix A for materials). Half-page flyers in English and Spanish were distributed to families of youth attending summer programming at sites. These flyers emphasized: a) the need for children to drink water for hydration, b) the pros of tap water and cons of SSBs, c) the high quality of Philadelphia water, and d) the availability of the new hydration stations at the centers. Programming was intentionally kept to a minimum to maximize sustainability for expansion of the program to other sites. Promotional materials are shown in Appendix A.

2.3.6. Decreased access to unhealthy foods and beverages

Staff encouraged students not to bring "black bags" (i.e., small, usually black, plastic bags characteristic of purchases from corner store) or other outside SSBs during PPR programming. The promotional flyers also encouraged parents and youth not to bring SSBs and instead to rely on the new hydration stations for chilled and appealing water. While implementing a complete ban on SSBs or outside competing foods is appealing from a public health perspective, this approach was not feasible, received pushback when previously attempted, and did not have the support of PPR leadership. Through discussions with PPR leadership and recreation center leaders, a more flexible approach of "discouraging" outside food and beverages was agreed upon as feasible and well-tolerated.

2.3.7. Intervention pilot study

The Hydrate Philly pilot emphasized testing numerous logistical and operational procedures including the timeline and workflow for station installation, acceptability of reusable water bottles, water quality testing procedures, and center feedback on ways to maximize the relevance of the group-based game. Lessons learned included the awareness of additional small parts needed for installation, the typical time required for install, the utility of involving center staff in observing the water quality testing to improve transparency, and a change in the style of reusable water bottles used for the study. In addition, using a pool in the group-based game to represent the center's own pool as a target for youth to place water droplet stickers was found to have great appeal and local saliency compared to other targets that were considered such as a famous city fountain or more general body of water.

2.4. Outcome measures

2.4.1. Overview of measurement procedures

Center staff were asked to report several measures (described below) daily at 3:30 pm each weekday for 2 weeks generating a total of 10 measured days per measurement period: flow meter reading, tally of reusable water bottles, sugary beverages, and bottled water observed, program attendance, and weight of the day's trash. The 3:30 pm afternoon time was selected as this was when staff were likely to have just finished with summer camp activities but before they left the center for the day. To minimize staff burden, a lead staff person per center was identified to report measures. If the center had additional staff, a second person was identified for reporting in cases where the primary staff person was out. Prior to baseline measures, center staff received a training on how to collect and report measures and were given a measurement "cheat sheet" highlighting key points from the training. Before each measurement period, brief booster measurement reviews were conducted by phone. Center advisory councils selected center equipment or supplies amounting to $25 as a thank you for staff time.

2.4.2. Center water consumption (primary outcome)

2.4.2.1. Flow meters. Center water consumption was measured in two ways. First, each center's total cumulative gallons of water used at a water source was measured by objective water flow meters (model DigiFlow 6700 M, 3/8"NPT) installed before baseline measures at all sites. For practical purposes, nine sites with two or more fountains had a flow meter installed in only one fountain (selected by the plumbers). Selected fountains were the most easily accessible and had the greatest use. Matching by fountain location and number of fountains was not feasible as the majority of sites had only a single water fountain and other site characteristics were prioritized for matching (e.g., center size, presence of vending machines). Intervention and control sites showed similar patterns of fountain locations and number of fountains and thus any differential fountain use was expected to be distributed equally across groups. As described above, recreation center staff members texted daily readings from flow meters to research staff each weekday throughout each 2-week measurement period for a total of 10 readings. The flow meters displayed cumulative gallons digitally in integers. Flow meter reading validity was checked with supplemental readings by research staff. Once new hydration stations were installed, flow meters from hydration station bottle counters were used to track center water use at intervention sites. This was necessary because the original flow meters could not be reinstalled inside the new hydration station units and could not be placed outside the units due to tampering.

2.4.2.2. Observations. Modified versions of previous water observation protocols [12,14] were used to collect data on fountain/station use at post-test at all sites as a secondary measure of center water use. During the 2-week post-intervention measurement period, each site was observed five times at the same time of day. Observations occurred during one of three set observation time periods: 10:30–11:00 am, 12:30–1:00 pm, or 2:30–3:00 pm. Observations were conducted such that treatment-control matched pairs were observed at the same time and on the same days. Research assistants were instructed to observe from an unobtrusive spot with a clear view of the fountain. Recreation center staff and visitors were not notified in advance that the observations were occurring. Research assistants tallied the number of visitors that were present in the center in the area of the fountain (e.g., hallway, lobby) and estimated the fountain flow rate for the bubbler by recording the amount of time (to 1/10 s) required to fill a 4-oz cup. For intervention sites, the time required to fill a 20-oz water bottle from the bottle filler was also recorded using the same method. The cup and bottle size approximated actual expected drinking times and volume for the bubbler and bottle filler, respectively. Each time a visitor used the fountain or bottle filler, research assistants used a stopwatch to time how many seconds the fountain was on and in use during each use and whether a reusable water bottle (i.e., not including refilling single-use plastic bottles or cups) was used. Total observed water consumption at each center was estimated by summing each timed fountain use during the 30-min observation period and multiplying by one of two rates established in previous studies corresponding to assumed rate of consumption [14]. For use of the bubbler, total time was multiplied by 32%, and for the bottle filler, total time was multiplied by 96% [14]. Average water consumed per fountain use was estimated by dividing total observed water consumption by total count of fountain uses. Percentage of center visitors using the fountain was estimated by dividing the total count of fountain visits by the total count of visitors in the center.

2.4.3. Outside beverages during programs (secondary outcome)

Outside beverages brought in by youth to after-school and summer programs were measured as the proportion of program youth at the center in attendance that was observed with an outside SSB. Center staff tallied the total number of children in summer camp and the number who had SSBs and sent daily tallies by text as described above each weekday for 2 weeks at baseline, mid-point, and post-intervention measurement periods. Daily proportions were averaged to create one center-level estimate of average daily proportion of children bringing in SSBs.

2.4.3.1. Use of reusable water bottles and single-use bottled water (secondary outcome/mediator). Center staff tallied the number of youth who had reusable water bottles and single-use bottled water during summer camp following the same texting approach as outside beverages.

2.4.3.2. Program trash (secondary outcome). Program trash was measured in two ways. First, each weekday for 2 weeks, center staff used a digital portable luggage scale to measure daily program waste. Staff were asked to select one trash can that was used most by summer camp youth and measure that trash can for the entirety of the study. Weight of trash was adjusted for number of youth attending the program. Second, at post-intervention research staff included tallies of all single-use containers observed during the 30-min period on 5 separate program days. These 5 observations were totaled to create one measure of total estimated single-use containers per site.

2.4.3.3. Staff SSB consumption (secondary outcome/mediator). At baseline, mid-point, and post-intervention and prior to the start of each measurement periods, 1–2 staff at each center completed a previously validated Beverage Intake Questionnaire (BEVQ-15; [19,20]. This questionnaire will be used to estimate staff SSB and

Table 2
Baseline site characteristics for recreation centers participating in the Hydrate Philly trial.

Baseline site characteristics[a]	Total[b] (n = 28)	Intervention (n = 14)	Control (n = 14)
Site characteristics (%)			
Afterschool program enrollment, mean (SD)	26.61 (12.13)	29.00 (12.69)	24.21 (11.5)
Summer camp enrollment, mean (SD)	53.64 (30.17)	54.00 (30.88)	53.29 (30.6)
Percent of residents living at or below Federal Poverty Level[b], mean (SD)	33.88 (12.7)	35.99 (14.36)	31.76 (10.91)
Percent of residents that are racial/ethnic minorities[c], mean (SD)	76.64 (18.66)	71.44 (19.95)	81.84 (16.34)
Indoor gym	53.6	50.0	57.1
Vending machines with SSBs and water	32.1	28.6	35.7
Tenure of site leader (months) mean (SD)	50.11 (73.57)	46.79 (61.84)	53.43 (85.99)
Maintenance capacity			
No maintenance staff	35.7	50.0	21.4
Part time staff only	32.1	21.4	42.9
Full time staff	32.1	28.6	35.7
Water access and appeal			
Location of center's primary fountain			
Main lobby	28.6	28.6	28.6
Main hallway	35.7	35.7	35.7
Multipurpose room	17.9	14.3	21.4
Gym	3.6	7.1	0.0
Secondary lobby/hallway	14.3	14.3	14.3
Number of functioning water sources			
Zero	3.6	7.1	0.0
One	64.3	64.3	64.3
Two	25.0	21.4	28.6
Three	7.1	7.1	7.1
Water temperature (F), mean (SD)	58.44 (10.58)	57.85 (10.37)	58.99 (11.13)
Time to fill an 8 oz. cup (seconds), mean (SD)	10.38 (1.88)	10.80 (1.73)	9.98 (1.98)
Staff confidence in water safety			
None or not very confident	7.1	14.3	0.0
Unsure	21.4	7.1	35.7
Somewhat or very confident	71.4	78.6	64.3

[a] Mean (standard deviation) is reported for continuous variables. Percentage is reported for categorical variables.
[b] *t*-Tests and chi-square tests showed there were no statistically significant differences between treatment and control groups on any baseline characteristics.
[c] Determined using Census 2010 data for the zip code the recreation center is located in.

water consumption using frequency (i.e., number of days in the past 30 days that an SSB was consumed), ounces (i.e., frequency multiplied by typical volume consumed), and total energy intake from beverages following established protocols [20]. Total SSB and water consumption in the past 30 days included SSBs and water consumed away from intervention sites.

2.4.3.4. Center attendance and visits (covariate). Attendance was recorded each weekday by staff for 2 weeks and will be used as a covariate or to adjust some measures that are contingent on program size (e.g., weight of trash, proportion of youth consuming water). Observations by research staff post-intervention were used to estimate total visits to the center during the 30-min observation period.

2.4.3.5. Fountain maintenance. A survey was developed for the current study to measure key aspects of fountain maintenance including removal of trash, food/gum, graffiti, dust/dirt, and bodily secretions as well as fountain clogging and flooding based on previous research measuring these aspects of fountain cleanliness [21]. Center liaisons or maintenance staff responded to eight questions about the previous week on a 4-point scale (i.e., everyday, three to four times, once or twice, or never) indicating how often they had to perform the various maintenance cleanliness tasks. Responses will be averaged to create one rating of frequency of maintenance. Staff also estimated how much time it typically took to maintain the fountain. Fountain maintenance surveys will be measured at post only.

2.4.3.6. Fidelity assessment. Intervention fidelity was assessed in 2 ways: through center liaison self-reports and by independent observation. During the first week of summer camp, centers self-reported via a phone call whether or not they had distributed water bottles, posted the weekly water challenge game for camp use, and distributed promotional flyers. The following week, research staff visited sites to conduct fountain observations (described above) and record the number of children seen with branded program reusable water bottles, and whether the game poster was displayed at the center.

2.5. Proposed statistical analysis

The unit of analysis will be the center, and (with the exception of staff beverage consumption) no individual level data is planned for collection, thus meeting the assumption of independence of residuals across centers. Therefore, ordinary least squares regression following a difference-in-differences approach will be used to examine the effect of the intervention on each outcome variable, adjusting for baseline values covariates. Unmatched analyses will be used due to the limited degrees of freedom available in the current study for matched analyses [22]. Two-tailed tests at $p < .05$ will be used to determine significance. Covariates that will be considered for inclusion in initial models are center size, the age category (3–5, 6–12, or 13–19 years) of the youth primarily served at the center, number of functional water fountains at baseline, the number of vending machines in the center, the number of corner stores within 3 blocks of the center, weather (i.e., outside temperature), fountain water temperature and flow rate, and total visits to the center from fountain observations. Covariates will be selected using a combination of a priori theoretical justification and through assessing statistical significance with the outcome. Given the lack of available data to estimate power using center level estimates of total water consumption, child-level estimates were used instead. Power was calculated with a multilevel model using n = 10,000 simulations, assuming an alpha level = 0.05, a correlation of 0.30 across the 3 measurement periods within centers, and a range of effect sizes based on those seen in previous water promotion interventions in schools and after-school programs [5,10,13]. With 28 centers, the current study has 82%, 99%, and 100% power to detect changes of 2 oz., 4 oz., and 6 oz. of water per student per day, respectively.

3. Results

Baseline characteristics of study centers are shown in Table 2 According to Census 2010 data, neighborhoods where participating centers were located had a high percentage of residents at or below the Federal Poverty Level (mean = 34%, range = 13–53%). There were no significant differences between treatment and control sites on any baseline site characteristics. Of the youth attending centers (n = 2586), the majority were from African American (64.3%) racial/ethnic background, with representation from other diverse groups as well: Hispanic (13.3%), Caucasian (13.0%), other (7.7%), both Hispanic ethnicity and another race category (n = 158). Race/ethnicity data was missing for 203 youth. The ages of youth participating in PPR programs were 3–5 years (4.8%), 6–12 years (85.4%), 13–19 years (9.2%), and unknown (0.6%).

Fountains were predominantly located in main lobbies (29%) and main hallways (36%) although multipurpose rooms (18%), and secondary lobbies/hallways (14%) were other common locations. Approximately half of centers had indoor gyms and almost a third had vending machines. Water temperature was 58 degrees Fahrenheit (15 degrees Celsius) on average but ranged from 47 to 81. Approximately 29% of center leaders at sites participating in Hydrate Philly indicated they were unsure or did not have confidence in the safety of the water, emphasizing the need to address water quality concerns. Lead results (using the flushed sample) ranged from < 3–9 ppb, and all other water safety and quality measures for centers were within normal and safe ranges.

4. Discussion

Meeting drinking water needs is vital to cognitive [2,23], physiological [1,3], and emotional [24,25] health. However, limited access to appealing water across settings makes this challenging. Moreover, children may be at particular risk for dehydration when compared to adults due to unique body cooling mechanisms, a higher surface-to-mass ratio, different thirst sensitivities, and limited control over their own fluid intake [4,23]. Community recreation centers, such as those in the Hydrate Philly intervention, represent a novel setting to improve youth's access to tap water.

Beyond the positive impacts of hydration alone, replacing intake of SSBs with water has been shown to be beneficial to weight loss in adults [26,27] and in the prevention of weight gain or for weight loss in youth [28–30]. Importantly, the provision of water has been linked with the reduction of SSB consumption in some studies [28,30,31] but not all [32]. Replacement of SSBs is important for low-income and minority youth who are more likely to consume SSBs [7] and to visit corner stores frequently to purchase SSBs [6,33].

Water promotion interventions in schools suggest weight status benefits [32,34]. A cluster-randomized trial with almost 3000 children from socially deprived areas in Germany found a 31% reduced risk of overweight in schools with water fountains installed compared to controls but no change in BMI standard deviation scores [32]. A quasi-experimental study of 1227 elementary and middle schools (n = over 1 million students) in New York City tested the effect of installation of water jets in 39% of schools on obesity [34]. This study showed statistically significant improvements in standardized BMI (boys and girls), likelihood of overweight (boys and girls), and obesity (boys only) in schools with water jets compared to those without jets. While important potential confounders were not accounted for, these results provide preliminary support for the role of community-based water access and consumption for maintaining a healthy weight. The Hydrate Philly trial builds on the existing evidence through the use of a randomized study design that incorporates measures of both water and SSB consumption, which has implications for energy balance, and includes a predominantly low-income and high-minority population at high risk for the development of chronic disease.

While previous studies have demonstrated that summer months may compromise youth's progress on academic and health outcomes, including summer weight gain [35,36], few studies have intervened with children outside of the school setting and over the summer months. Previous interventions to increase access and consumption of water have predominantly focused on school settings [10,12] or school-based after-school programs [13]. The Hydrate Philly intervention fills this gap by targeting youth summer camp and afterschool programming at recreation centers, which could have wide reach during critical out of school time and may uniquely address underserved children's increased risk for summer weight gain and after-school exposure to SSBs [6,35].

While the benefits of adequate hydration and limited SSB consumption are numerous and clear, past research and baseline data from the current study document the challenges of increasing youth's water consumption. That is, at baseline more than 1 in 4 center leaders at Hydrate Philly sites had concerns about water quality, one site did not have an operational water fountain due to a malfunction that necessitated temporary use of bottled water, and some sites had warm water temperatures that can hinder water intake. National data has shown that approximately 2 in 5 students disagreed that their school water fountains were clean and safe, a concern sometimes shared by community stakeholders [9,37]. This sentiment was significantly more common in non-Hispanic black and Hispanic students [37]. Furthermore, in non-white racial/ethnic groups, tap water concerns were significantly associated with a lower likelihood of consuming plain water [37]. In another study, one in six youth did not drink tap water, and this finding was more pronounced in non-Hispanic black and Mexican American youth, which may contribute to health disparities [5]. Concerns about tap water safety raised across the country emphasize the need to address the safety of drinking water as well as negative perceptions of tap water even when tap water supplies are safe. The Hydrate Philly intervention seeks to address community concerns about drinking water quality by incorporating water quality testing and sharing those results to facilitate transparency. As water safety testing results in the current study demonstrated the high quality of the water at recreation centers in Philadelphia, it is important to communicate this information to the public.

Strengths of the current study include the examination of the impact of a multi-level beverage intervention in non-school settings and the focus on an underserved population at high risk for future development of chronic disease. In addition, in this study, researchers collaborated with community agencies to develop an intervention that would be feasible to implement, largely sustainable even after the grant period ended, scalable at a population level, and would be well-received by other departments, organizations, and cities. The study also has weaknesses. While individual level outcomes on students' drinking behaviors were not collected in this study, consumption is believed to be reasonably approximated by center level outcomes. Second, although some non-consumption water use from water fountains (e.g., rinsing cups, wasted water) may occur this is expected to be similar across treatment and control groups, and observations at post-intervention can be used to approximate consumption versus non-consumption water use. Lastly, health outcomes were not included.

In summary, the Hydrate Philly intervention is a multifaceted intervention to promote water access and appeal for staff and youth in underserved community recreation centers. A rigorous, randomized control trial design will evaluate the impact of Hydrate Philly on youth and staff beverage intake, providing information about the feasibility and effect size of the program that can inform future studies focused on the impact of Hydrate Philly on health.

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HGL, GT, and AP conceptualized the study. HGL drafted the manuscript and performed analyses; XL, SG, MP, and MR implemented the intervention and oversaw data collection; All authors critically reviewed and approved the manuscript.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.cct.2019.02.003.

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